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ABSTRACT

This curriculum guide consists of 14 units for use in teaching a high school level horticulture course. Covered in the individual units are the following topics: opportunities in horticultural occupations; plant classification and identification; structures and equipment used in producing greenhouse, ornamental, and nursery plants; greenhouse environment; soils and plant growth and development; propagation of plants; growing greenhouse plants; nursery plant production; developing and maintaining the landscape; establishing and caring for turf; soil and plant diseases, insects, organisms, and weeds in horticultural plants; floral arrangements; greenhouses and nursery business management; and horticultural equipment operation, maintenance, repair, and safety. Each unit contains some or all of the following: suggested procedures and activities, instructional text, transparency masters, and a list of related references. (MN)

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CVAE-VEH HORTICULTURE

COURSE OUTLINE

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Vocational Instructional Services in Agricultural Education
Texas A and M University
College Station, TX 77843

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COURSE OUTLINE

CVAE - VEH HORTICULTURE

Unit A	Opportunities in Horticultural Occupations	1. Introduction to Horticulture and Horticulture Occupations
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		3. Choosing an Occupation
		4. Finding a Job and Preparing for an Interview
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		4. Soil Sterilization
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Unit H	Nursery Plant Production	1. Growing Nursery Stock 2. Growing Ornamentals in Containers
Unit I	Developing and Maintaining the Landscape	1. Landscape Planning 2. Preparing the Landscape Plan 3. Maintaining the Landscape
Unit J	Establishing and Caring for Turf	1. Turf Grasses of Texas 2. Establishing a New Turf 3. Managing an Established Turf 4. Turf Problems
Unit K	Soil and Plant Diseases, Insects, Organisms, and Weeds in Horticultural Plants	1. The Safe Use of Chemicals in Controlling Diseases, Insects, Organisms, and Weeds 2. Identification and Control of Plant Insects 3. Identification and Control of Plant Diseases
Unit L	Floral Arrangements	1. Floral Design Accessories 2. Designing Floral Baskets, Vases, and Miscellaneous Tributes
Unit M	Greenhouse and Nursery Business Management	1. Calculating Production Costs 2. Labeling, Pricing, Displaying, and Advertising 3. Financial Control, Credit, Records, and Accounts 4. Marketing
Unit N	Horticultural Equipment Operation, Maintenance, Repair, and Safety	1. Lawn Mowers, Edgers, Rotary Tillers, Cement Mixers, Shredders, and Mulchers 2. Sprayers, Dusters, and Fertilizer Ejectors

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Agricultural Education

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CVAE AND VEH HORTICULTURE

Unit A: Opportunities in Horticultural Occupations

Topic 1: Introduction to Horticulture and Horticultural Occupations

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction

Horticulture is one part of a very large agricultural industry. The word "horticulture" derived from Latin, meaning "cultivation of gardens." With today's usage, the word horticulture has many meanings. It is, however, most often associated with flowering and ornamental plants.

Transparency No. 1

The three major fields of horticulture are (1) floriculture, (2) pomology, and (3) olericulture. Floriculture is the production, cultivation, and management of ornamental and flowering plants. Pomology is the production, processing, and distribution of fruit crops. Olericulture is the production, storage, processing, and marketing of vegetables.

Areas of horticulture may be further broken down into (1) greenhouse production and management, (2) nursery production and management, (3) landscape establishment and management, (4) turf grass establishment and management, (5) greenhouse crop production, and (6) retail flower shop operation and management. This list is not inclusive, and other categories could be listed. Also, a number of horticultural occupations could be listed under each category.

2. Early Development of Horticulture Industry

The development of the horticultural industry can be traced to Asia many thousands of years ago. Evidence is available that beautiful gardens were found in this area. To establish and maintain these gardens required much knowledge and skill.

Only rulers and other rich people during this period could afford to maintain expensive and elaborate gardens. Their gardeners handed down the knowledge they had acquired after a lifetime of learning and working with plants to their sons or to apprentices.

According to available literature, the first forcing structure (greenhouse, lathehouse, hot bed, and cold frame) was built by Emperor Tiberius. Because of a serious illness, a daily diet of cucumbers was prescribed by Tiberius' physician. Surprisingly, Tiberius was able to grow the cucumbers in the winter with the use of a forcing structure, and the diet was followed. Following Tiberius' example, others began to use similar structures to grow plants. Lilies, grapes, and roses were some of the first plants to be grown.

Ancient Romans applied heat to their forcing structures by building fires along the side of the structures. The Romans called the structures specularia. Strange as it may seem, these structures were covered with a material which resembled our present day plastic.

The first account of the use of a greenhouse as a forcing structure was during the 12th century. Much of the writings of Albert Magnus, a Domincan monk and great medieval scholar, includes the culture of plants. He is credited with reviewing the Roman practice of forcing vegetables, fruits, and other plants in a structure he referred to as a hothouse.

Because of Magnus' unusual success with the growth of plants, many people became suspicious and charged him with witchcraft. The difference between the structure used by Magnus and the ancient Romans was the covering. Magnus covered his structure with sheet glass.

The first greenhouse was constructed in England in 1825. This structure was covered with glass, which was used as a covering for the next 100 years. There possibly would have been many more greenhouses constructed during this time, but glass was very expensive and heavily taxed.

3. Economic Importance of Horticulture

The producitor and selling of horticulture plants is a relatively new business in America. This is particularly true of landscaping and home beautification. Up until the middle of the 19th century home beautification in the U.S., for the most part, was enjoyed by only a few wealthy people. The last few decades has resulted in a tremendous change. Construction of new homes, private and public buildings, parks, golf courses, and other recreational areas and out-door living at home has increased the demand for landscape services.

Accurate data on the production and sales of all horticultural plants, growing media, and supplies are not available. However, there is enough data for one to realize that the industry has a great economic impact on the state and nation.

Transparency No. 2

In the 1976-77 Texas Almanac, it was reported that sales by retail nurseries and lawn and garden supply stores was $42.9 million in 1972. Sales of fruit stores and vegetable markets in the same year were $18 million. Florists' sales amounted to $82.7 million during 1972. Texas ranked third nationally in dollar volume of nursery stock production. Sales and values of horticultural plants and related supplies has increased since this time.

Based on the data in the 1976 and 1977 statistics published by the Texas Department of Agriculture, the value of fresh and processed vegetables was $283 million. Cantaloupes, cucumbers, lettuce, spinach, tomatoes, cabbage, and carrots were some of the vegetable crops for which data were collected. Cash receipts for fruits and nuts (grapefruit, pecans, oranges, peaches, etc.) in 1976 was $47.4 million. Greenhouse and nursery receipts for the same year were $39.8 million.

In 1970, 13.3 percent of all the farm receipts in the U.S. were from horticultural commodities. This represents a value of approximately $6 billion. To illustrate just how much money this is, assume we have a stack of new $1,000 bills. If we stack one on top of each other, one million dollars would be represented by a stack six inches high. One billion dollars on the other hand would be a stack of $1,000 bills five hundred feet high. Six billion dollars then would reach over a half mile into the air.

It has not been too many years ago that a person wanting to buy flowers had to go to a florist shop. Consumers today can purchase flowers and other horticultural plants from drugstores, supermarkets, and even hardware stores. This is an indication of the booming market which has developed in the U.S..

Up until recently, the Statistical Reporting Service, USDA, gathered only production data, sales figures, and planting intentions for several varieties of carnations, chrysanthemums, roses, gladoli, and foliage plants. Due to the increase in demand and sales, other plants have been added to the surveys. Also the number of states surveyed has been increased from 22 to 27. These 27 states account for 95 percent of the total production.

Included in the SRS surveys are growers producing one or more of 16 horticultural crops and those with sales of $10,000 or more. A survey conducted in 1976 shows that the wholesale value of eight flower crops increased 10 percent from the previous year and was $259 million. The value of foliage plants increased 28 percent during the same period and amounted to $236 million. Combined totals of the nine crops originally surveyed in 1976 was $495 million, an increase of $65 million over 1975.

The addition of the new crops in the 1977 survey increased the wholesale value to approximately $703 million. Cut and potted flowers made up $347 million of total value, while bedding and foliage plants accounted for the remainder of the $703 million.

Wholesale values, number of producers, and number of square feet of space for the 16 plants are shown in the following transparency.

Chart No. 1

Even though the above data reveal that the horticultural industry presently has a great economic impact on the nation, it is expected that the production and demand potential are yet to be reached.

Vegetable bedding plants are the most valuable crops based on a square foot basis. The plants earn an average of $3.10 per foot. Potted mums and tea roses are second with a value of $2.99 per square foot.

4. Horticulture Course Objectives

In order to meet the needs of the horticultural industry, pre-employment laboratory training courses in horticulture have been established in a number of school districts in Texas and in most other states in the U.S..

The principal objective for establishing the courses is to provide students with the opportunity to acquire salable horticultural skills, and/or to prepare the students for employment in jobs requiring semi-skilled knowledge and training. The student is also expected to acquire knowledge in academic areas such as math, science, English, and social studies. An objective of the CVAE and VEH horticulture courses is to assist students to enter the regular high school vocational program.

Plants Included in SRS Surveys in 27 States

Crop	No. of Producers	Wholesale Value 1975	Wholesale Value 1976	Production Area Intended 1976	Production Area Intended 1977
		Million dollars		1,000 square feet	
Carnations, standard	539	43.2	45.6	28,768	27,959
Carnations, miniature	221	4.7	5.6	2,706	3,012
Chrysanthemums, standard	1,029	29.4	29.3	22,401	21,511
Chrysanthemums, pompon	1,126	31.1	34.2	37,412	34,520
Chrysanthemums, potted	1,339	42.2	52.9	17,689	17,903
Gladioli	77	17.1	17.2	8,330	8,183
Roses, hybrid tea	230	54.3	58.7	23,420	22,482
Roses, sweetheart	192	13.8	15.7	5,240	5,078
Foliage plants	1,685	184.9	235.8	116,299	125,455
Snapdragons	572	-	2.8	2,479	2,401
Poinsettias, potted	1,747	-	35.5	21,572	23,169
Geraniums, potted	2,234	-	30.4	14,816	15,814
Lilies, potted	1,219	-	13.9	5,792	6,067
Hydrangeas, potted	448	-	5.0	2,950	3,003
Bedding plants, flowering	2,541	-	62.0	31,870	33,170
Bedding plants, vegetables	2,343	-	58.0	15,245	15,681

Pre-Lab. CVAE and VEH Horticulture

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Chart No. 1

HORTICULTURAL FIELDS & CLASSIFICATION

FIELDS

FLORICULTURE -	production, cultivation, & management of ornamental & flowering plants
POMOLOGY -	production, processing, & distribution of fruit crops
OLERICULTURE -	production, storage, processing, & marketing of vegetables

AREAS OF HORTICULTURE

GREENHOUSE PRODUCTION & MANAGEMENT

NURSERY PRODUCTION & MANAGEMENT

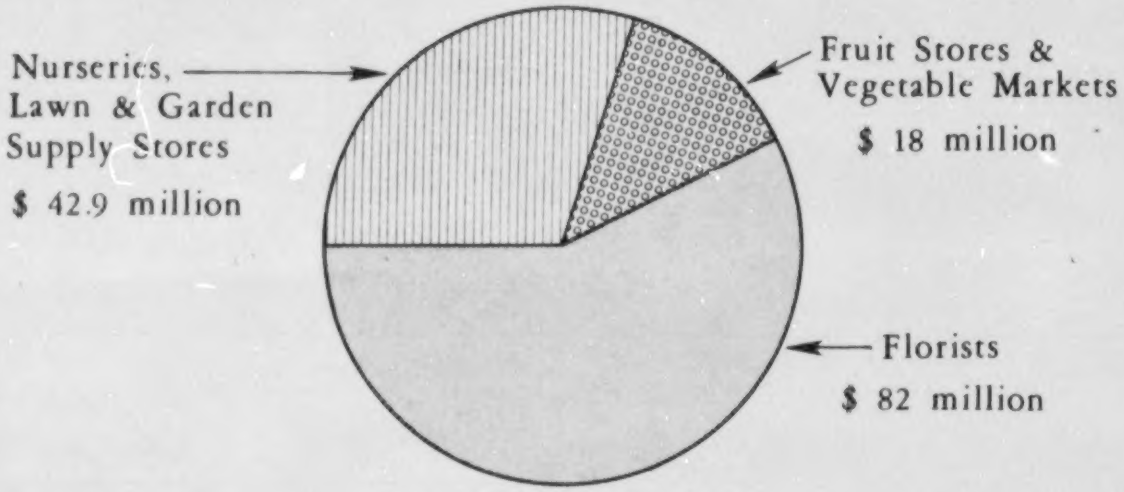
LANDSCAPE ESTABLISHMENT & MANAGEMENT

TURFGRASS ESTABLISHMENT & MANAGEMENT

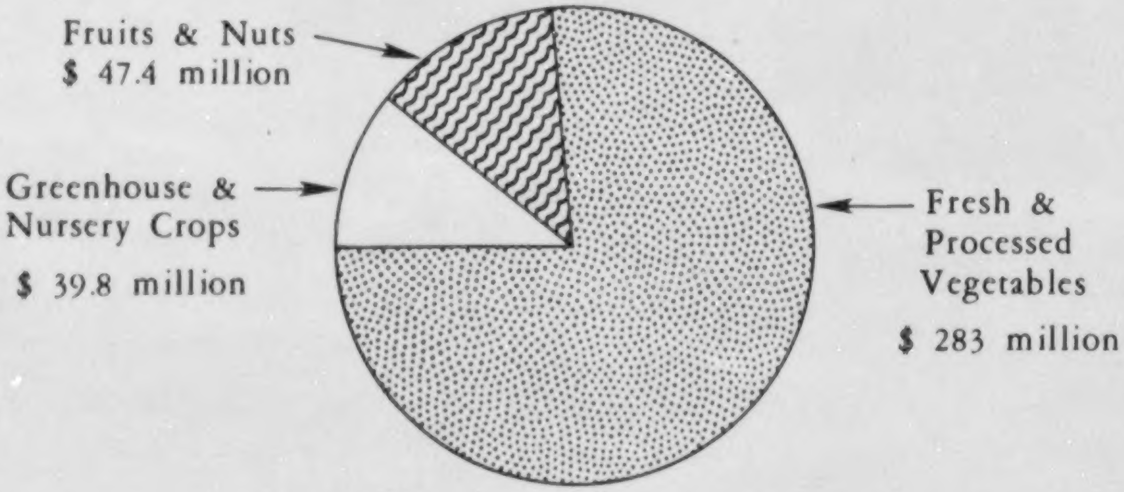
GREENHOUSE CROP PRODUCTION

RETAIL FLOWER SHOP OPERATION & MANAGEMENT

VALUES OF HORTICULTURAL CROPS



RETAIL SALES



CASH RECEIPTS TO PRODUCERS

CVAE AND VEH HORTICULTURE

Unit A: Opportunities in Horticultural Occupations

Topic 2: Employment Opportunities and Occupation Requirements

Note: All terms underlined are included in the "Glossary of Terms."

1. Employment Opportunities

All areas of horticulture in Texas offer employment possibilities for the well-trained individual. Employment opportunities span the occupational spectrum. A knowledge of horticulture, however, is necessary to become established in the industry.

A knowledge of horticulture can be acquired by several methods. One method is to become employed in the industry as an unskilled worker and progress as knowledge is acquired and skills are developed. This method is usually a slow, tedious process, and the monetary rewards are small for a long period of time. A better method is to take advantage of the pre-employment laboratory training course offered in your school. Through maximum effort in both the academic and laboratory phases of the course, the student can become prepared to enter a horticultural occupation at a higher level of responsibility and pay.

2. Occupational Requirements

The horticultural industry is similar to other industries in that a person must possess basic skill levels for employment within the industry.

Chart No. 1

The rungs or steps on a ladder may be used as an example of the different levels of occupations in horticulture. Each rung up the ladder requires more training and education. The salary range listed for each step is the average for the industry. An employee may make more or less than is shown. Also there may be occupations in addition to the ones shown under each step.

The unskilled worker is the lowest step of the ladder. Previous experience and knowledge are not required. However, the worker should possess a good work attitude and have the ability to work physically and to get the job done. The unskilled worker is given close supervision. Jobs and description at this level might be as follows:

1. Helper - This job consists of a number of duties, and the worker would usually be helping a more experienced employee.

2. Laborer - Duties usually include doing much of the manual work such as moving soil, planting stock, and weeding plants.

3. Packer - Flower packing or the preparation of plants for shipment could be the major responsibility of this job. Women are often employed to pack flowers.

4. Potter's Helper - Potting, propagation, and caring for greenhouse plants might be a part of this job.

5. Tree Surgeon Helper - This job requires the employee to follow the directions of the tree surgeon in the pruning, spraying, and treating of diseased trees and shrubs.

The next rung up the job ladder is the semi-skilled worker. Semi-skilled workers have specialized but limited knowledge of routine processes and techniques. The worker performs under limited supervision. Occupations as a semi-skilled employee might be as follows:

1. Bagger and Burlap Worker - An employee possessing the skills for this job selects trees or shrubs, digs them, and bags the roots in burlap.
2. Grounds Keeper - Industrial, commercial, and public grounds may be maintained by a person employed for this job.
3. Park Worker - This job requires the person to take care of and keep clean the grounds of city, state, and national parks. Building and equipment maintenance may also be a part of the job.
4. Greenhouse Potter - A knowledge of soil, fertilizer, and water requirements of plants is required. The individual may have advanced from a potter's helper.
5. Tree Planter - Planting of trees and ornamental plants are included in this job description. The plants may vary in size from seedlings to mature plants.

The skilled worker is the next rung in the ladder of advancement. This individual is often called a craftsman of the trade and has the ability and technical knowledge to perform a number of skills. Some of the jobs in this category are discussed below:

1. Artificial Flowermaker - A flowermaker has the skills needed to make, combine, and arrange artificial flowers.
2. Flower Grower - This person grows cut flowers, flowering bulbs, rootstocks, or shrubs. All of the duties required for flower growing are included in this job description.
3. Landscape Gardener - The planting and carrying out of small scale landscaping operations and maintenance of grounds and landscapes of private and business grounds are some of the responsibilities of this job.
4. Nursery Worker - A nursery worker plants, cultivates, transports, fumigates, propagates, and harvests flowering plants, trees, or shrubs which are common to the nursery business.

5. Tree Surgeon - A tree surgeon has the responsibility of keeping ornamental plants, trees, and shrubs healthly and properly trimmed. Pruning, treating, spraying, and controlling growth of various trees and shrubs found in yards and parks are also a part of the job.

The higher step on the ladder of advancement is the supervisor. This person supervises and manages groups of unskilled, semi-skilled, or skilled workers. Some jobs at the supervisory level are as follows:

1. Greenhouse Foreman - The foreman is in charge of a crew of greenhouse workers and is responsible for the proper operation of the greenhouse.
2. Planting Foreman - This person is responsible for all plantings, seedings, and sodding according to the recommendations of the landscape designer.
3. Greenskeeper - The supervision and coordination of the activities involved in keeping the grounds of a golf course in proper playing condition are the responsibilities of a greenskeeper.
4. Nursery Supervisor - This person is in charge of the nursery. The nursery supervisor decides what kind, how many, and under what conditions trees and shrubs are grown. Supervision of the nursery workers is also a part of the job.
5. Park Caretaker - Park caretakers are in charge of maintaining clean grounds and buildings for the enjoyment of people in city, state, and national parks. A number of employees are under their supervision.
6. Park Foreman - This job is closely related to the park caretaker. The major job is to supervise and direct park workers.
7. Greens Superintendent - The responsibilities of this job are to supervise and direct the construction and maintenance of new and old golf courses. The greens superintendent is also responsible for the hiring of workers.

The next distinct group of jobs are the salespersons. Salespersons must have the ability to work with and get along with customers and to satisfy the customers' needs. Salespersons have the opportunity of selling flowers, florist supplies, garden supplies, and nursery stock. They must have the technical knowledge to determine the desires and needs of the customers.

The next level of employment is that of the technicians. They are trained in a limited area and have the ability to apply their knowledge to specific tasks. Two jobs of the technician are discussed below:

1. Floral Designer - A floral designer selects, designs, plans, and fashions floral pieces and decorations for events or personal requests.
2. Landscape Designer - The landscape designer designs and determines specifications for landscaping private, public, or commercial areas.

The highest rung on the ladder of advancement is that of the professionals. They also receive the highest pay. To reach this rung, one must be broadly- trained in theory and application at a technical school or university. Some of the professional job opportunities are given below:

1. Horticulturist - The professional horticulturist conducts research and investigations of problems related to the breeding, production, storage, processing and transportation of fruits, nuts, berries, vegetables, flowers, shrubs, and trees.

2. Landscape Architect - Duties required of this profession are planning and designing land areas for parks, airports, hospitals, schools, and parkways for commercial, industrial, and residential sites. Another responsibility is the inspection of all landscape construction to insure that specifications are met.

3. Ornamental Horticulturist - Research and investigations related to the improvement of quality and production of ornamental plants such as flowering bulbs, perennials, annuals, shrubs, trees, cacti, aquatic plants and vines are the responsibilities of the ornamental horticulturist.

4. Arboriculturist - The arboriculturist is involved with the culture and artistic planning and trimming of trees.

5. Park Naturalist - A park naturalist plans and coordinates exhibits or activities that inform the public of historical, natural, and scientific features of city, state, and national parks.

6. Pomologist - The pomologist conducts research and investigations on fruits, nuts, and berries.

7. Olericulturist - Research and investigations on leafy, bush, vine, and root vegetables are conducted by the olericulturist.

As we have seen, there are many different jobs available in the horticultural industry. Some of the jobs require physical strength, while the others do not. A person interested in a horticultural occupation should have an interest in plants and must be willing to get dirty.

The pre-employment laboratory training in horticulture student may think that the only jobs available are those requiring manual labor. It is true that many of the beginning employees in the horticultural industry start at the entry level. However, those individuals possessing the proper attitude, having a willingness to work, and an interest in learning can surely go up the ladder of advancement. A person might be reminded that usually the larger the business, the more likely will be the chance for advancement.

Ladder of Advancement for Horticultural Occupations

Job Qualification		Salary Range Monthly
Bachelor's degree	**Professional** 1. Horticulturist 2. Landscape Architect 3. Ornamental Horticulturist 4. Arboriculturist 5. Park Naturalist 6. Pomologist 7. Olericulturist	$1,000 - $1,500
High school diploma and technical school or college. Some states require a written test and work experience to be certified.	**Technician** 1. Floral Design 2. Landscape Designer	$ 800 - $1,200
High school diploma, some college, enjoy working with people	**Sales person**	$ 600 - $1,000
High school diploma, some college, on-the-job training	**Supervisor** 1. Greenhouse Foreman 2. Planting Foreman 3. Greens Keeper 4. Nursery Supervisor 5. Park Caretaker 6. Park Foreman	$ 600 - $ 800
High school diploma, on-the-job training, ability to work physically	**Skilled Worker** 1. Artificial Flower Maker 2. Flower Grower 3. Landscape Grower 4. Nursery Worker 5. Tree Surgeon	$ 500 - $ 750
On-the-job training, ability to work physically	**Semi-Skilled Worker** 1. Bagger and Burlap Worker 2. Grounds Keeper 3. Park Worker 4. Greenhouse Potter 5. Tree Planter	$ 450 - $ 700
Good attitude, ability to work physically	**Unskilled Worker** 1. Helper 2. Laborer 3. Packer 4. Potter's Helper 5. Tree Surgeon	Near Minimum Wage

CVAE AND VEH HORTICULTURE

Unit A: Opportunities in Horticultural Occupations

Topic 3: Choosing an Occupation

Suggested Procedures and Activities:

The teacher may wish to make copies of the personal inventory and occupational requirements forms and make them available to students. These appear at the end of the technical information.

1. Importance of Choosing a Career

The occupation in which one is employed is the central activity around which Americans plan their lives. In addition to determining a person's way of life it influences choice of friends and the way in which leisure time is spent. It is also the major factor in a person's identity.

The average individual works in an occupation about 2,000 hours a year, or about 80,000 hours in a lifetime. These figures are based on a 40-hour week, 50 weeks a year for a period of 40 years. Most people begin working in an occupation in their early twenties and retire at the age of 65.

Since work has such a great influence upon the individual, selecting an occupation is one of the most important considerations in the life of a young adult. All young people should involve themselves in experiences which will prepare them for successful employment and will challenge them according to their aptitudes, interests, and personality.

2. Why People Work

Most people work because of (1) economic benefits, (2) social benefits, or (3) self fulfillment. A discussion of these and other reasons follows:

Livelihood - People work to provide their families with the basic essentials of life--food, clothing, and shelter. Once these needs are met, other needs become important.

Human Relationships - Employment provides companionship and association with other people. Most people seek companionship and prefer to work with others having similar interests. Being part of a group provides a feeling of belonging.

Personal Development - A job provides the opportunity for further self development and is a means of attaining goals by developing new skills and acquiring more knowledge. It allows one to reach the fullest potential.

Service - This is defined as tasks performed for the benefit or use of others. There is satisfaction in the production of quality products or the providing of a useful service. A person likes to feel that the work performed is of value to others and a contribution is being made to the general welfare of the community and country.

Security - An occupation or job is a form of security. Full-time employment and a regular income provide satisfaction and stability by eliminating the worries of an insecure future. Not all the "security aspects of a career" are in the form of wages or salaries. Fringe benefits such as insurance policies, retirement benefits, and vacation must also be considered. Various occupational choices may provide different forms of security to the worker.

Success - Ambitious people are interested in securing employment which offers an opportunity for advancement. Employers are interested in applicants who like a challenge and want to be successful in life. Employment provides a means of being successful.

3. Consequences of Choosing an Occupation

Each individual is "one of a kind" and has unique abilities, aptitudes, interests, and characteristics. Some people have strong emotional needs and may give very little thought to the financial returns from an occupation if these needs are met. Others may desire intellectual stimulation, while still others may desire the prestige of working with influential people, or employment in a upper level position. Some people desire to be a leader, exert power, or gain fame. Regardless of a person's needs and desires, the individual must realize that the occupational choice will have considerable influence on his/her life.

Some of the consequences of occupational choice are given below:

Transparency No. 1

1. The occupational choice may determine whether a person is employed, underemployed, or unemployed. Some occupations offer limited or part-time employment. Competition for jobs in some occupations is keen. If possible, the occupational choice should be one that is known to be relatively stable.

2. Occupational choice may determine a person's associates. Companionship and friendship are two of an individual's most basic needs. Nearly all people find it essential to visit with others who have similar interest. An occupation will provide more satisfaction if a person can "identify" with fellow employees in both work and leisure activities.

3. Occupational choice may determine success or failure. Many factors such

as ability, effort, and luck affect success, but of primary importance is the ability to perform the assigned tasks. People differ in both the nature and level of their abilities. Occupations differ in abilities required and performance levels. By choosing an occupation that will utilize strengths and make minimum demands of weaknesses, a person can increase chances of success.

4. Occupational choice may determine whether one likes or dislikes his work. In order to have job satisfaction, a worker must like to perform most of the tasks associated with the job. To some extent, individual interests and abilities will influence whether a person likes or dislikes his job. Most occupations have duties which are not enjoyable. A person should recognize that not all duties will be enjoyable, regardless of the occupation.

5. The occupational choice may determine one's contribution to society. Most occupations contribute directly or indirectly to the welfare of society. However, the occupational choice will determine the extent of the contribution and other peoples' opinion of the contribution.

6. Other aspects of life that may be influenced by occupational choice are area in which a worker lives, choice of friends, marriage partner, school children will attend, physical and mental health, salary, and visits to other members of family.

4. High School is the Crossroads

Much has been written and considerable effort has been expended in the United States to keep high school students from dropping out of school. Many thousands of the "dropouts", as they are called, have the erroneous assumption that quitting school and getting a job will solve many of their problems. In reality, this is just the beginning of their problems because most dropouts are destined to become common or semi-skilled laborers. Jobs as laborers do not offer the opportunities for advancement, gaining more knowledge, or improving and increasing skills.

Many "dropouts" have the ability to graduate from high school. Occupational knowledge and skills can be acquired while attending high school.

Technology is advancing at a very rapid rate, and it is expected that it will continue to advance. Many occupations require employees to continually upgrade their skills. To take advantage of employment in these occupations, the worker must have an educational background for the development of new skills. This is in contrast to a few years ago when a high school education was not important because employment was based more on physical strength rather than "brains." In the future there will be little opportunity in the labor market for the uneducated or the unskilled.

The decisions made by high school students will affect many of them for the rest of their lives. Some of the decisions that they must make at this time are as follows:

1. Whether to continue education in an area vocational-technical school, a community college, or a four-year college.
2. Should job be sought after completing high school?

While there is still time to plan for the future, consideration should be given to these questions. Any decision made at this time will involve a certain amount of risk; however, this should not be thought of as a final decision. Decisions should be based on their expected outcome. A decision based on facts and sound thinking will probably be a good decision. Study and time are required in the making of decisions. In the final analysis, each person must make the decision as to his/her status in life and must be prepared to adjust to the circumstances or outcomes of these decisions.

5. Personal Qualities and the World of Work

A student should recognize that individuals differ in abilities, talents, interests, attitudes, and ambitions and have different strengths and weaknesses. All people are not capable of doing the same thing, nor do all people want to do the same thing. Interests, abilities, and other characteristics, however, can be changed through the acquisition of knowledge and development of skills.

Career choices should be built around strengths, interests, and abilities. An attempt should be made to overcome weaknesses. If this is not possible, a career should be planned in which weaknesses will not hinder the occupational choice.

In order to make a realistic occupational choice, it is necessary for most students to conduct a self analysis. The purpose of the analysis is to determine what students really are, not what they think they are. Parents, teachers, friends, and guidance counselors are well-meaning and possess considerable knowledge and experience. The final decision, however, should be the student's. Serious consideration should be given to the following personal qualities when making the self appraisal.

Transparency No. 2

Ability - This refers to the capacity to perform. When it is said that a person has the ability to do something, it means that this person is skillful at performing the task. The ability may have been acquired through training and hard work, or because of a natural talent. Grades are an indication of the ability to perform in a certain subject matter area. Some students seem to have greater abilities in all subject matter areas, while others may be weak in one or more areas. Perhaps the class members have already recognized that they perform better in certain areas.

A self appraisal should reveal a true picture of the student's strengths and weaknesses. The school guidance counselor and teachers are familiar with tests that measure ability and achievement.

Talents - A person possessing the ability to perform certain tasks without training is said to have an aptitude or talent for these things. For example, the class may know of someone who learned to play a musical instrument with little or no instructions, while others develop a limited ability after years of study and instruction.

Talent may be defined as something a person does well. Those possessing special talents are fortunate. It is common for people to choose an occupation on the basis of their talents. If the self appraisal reveals that a student has a special talent, how this talent might be used in an occupation should be considered. Hobbies are often due to a source of talent and should not be overlooked in a self-appraisal. One might consider the following questions to determine special talents:

1. Do I write well?
2. Do I type well?
3. Am I a good speaker?
4. Do I play a musical instrument or sing well?
5. Am I mechanically inclined?
6. Can I perform physical feats well?
7. Can I work well with others?
8. Do I have a scientific and inquisitive mind?

Interests - Most people perform best when doing something they are interested in. A part of the personal inventory is to determine and understand self interest. This appraisal can be made by listing the things one likes best. These will be activities which excite the individual, things performed well, or in which one feels comfortable when doing. Consideration of the following may be helpful in developing the list:

1. Favorite subject(s) in school;
2. How spare time is spent;
3. School activities and clubs participation;
4. Social activities (church, youth organization, others) outside of school; and
5. Interest in people or things.

Most school counselors provide students with interest inventory tests. After interests have been determined, the student should make certain that these interests are permanent and lasting. Sometimes interests change. Occupations that appeal to students are not always appealing after becoming a mature adult.

Physical Make-up - Different occupations have different demands on the health, strength, and stamina of individuals. Physical and health limitations should be considered when making an occupational choice. Often persons with physical handicaps have been able to adjust and lead active, productive lives in occupations not adapted to their handicaps.

Educational Aspirations - Preparation is the key to success in a chosen occupation. An employer "buys" knowledge and skills when an employee is hired. A person needs salable skills, knowledge, and training to become employable. Much of the success of an employee depends upon competencies in a specific or related field of education or training.

A career choice should include plans for meeting the educational requirements of the occupation. It would be unwise to choose an occupation without preparing educationally. It would be foolish to try to become a mechanic without receiving the training.

Attitudes and Values - In a survey conducted of 100 of the largest companies in the United States, the company presidents ranked employee attitude as the single most important trait. It was ranked above possessed skills. Attitude is reflected in the treatment of others; the manner in which responsibilities are accepted; the perspective taken when faced with a problem; and the regards for job, supervisor, and company. A person with a good attitude will think positively, see the good in others, and will spend little time discussing unpleasant thoughts. Chances for success diminish with a poor attitude.

Values are those things that are important to a person. The values of parents and friends are imposed upon most young people. Some of these values will be retained, but others will be rejected. The amount of emphasis placed on different values changes throughout a person's life. Many of the things that are important today will be of little importance in later life. However, the present values held by a student will influence career plans. As a part of the self-appraisal of values, the student might consider the following questions:

1. Will my choice of an occupation agree with my attitude and values?
2. Can I express my attitudes and values in my work?
3. Will the people I work with have similar attitudes and values?

If the answers to the above questions are yes, then the student's choice of an occupation would appear to be in agreement with the values held. If an occupation interferes with the individual's values, a choice must be made to either readjust the values, or seek another occupation.

Personality - This is a set of habits which a person develops in reacting to people and situations. It reveals the kind of person one is and determines to a great extent how other people see a person. The student should consider the following personality traits to determine the impression that is being made.

1. Attitude
2. Courtesy
3. Enthusiasm
4. Friendliness
5. Honesty
6. Initiative
7. Loyalty
8. Morality
9. Self-contact
10. Sense of humor

Self-Concept - Self-concept is the way one views himself/herself. A self-appraisal should include the way the students view themselves in relation to the people they are in contact with. An occupation should be selected that will provide one with a satisfying self-concept.

Willingness to Change - It is very important that a prospective employee be flexible and willing to change. Most all employees encounter situations that require adjustments. The success in an occupation may depend upon the employee's ability to accept constructive criticism and willingness to make the proper adjustment.

Previous Experiences - Previous work experience should be appraised to determine the types of work that have provided the student with the most success. Work experiences can increase present interest and develop into new interests. Knowledge and skills can also be acquired, which will be helpful in a future occupation. Previous work experience can be a good indicator of success in a career. Satisfying part-time work experience often leads to satisfyingfull-time positions.

Chart Nos. 1A and 1B

A personal inventory form has been included for the student to record personal qualities. After completing this form, the student should have a good knowledge of his/her personal qualities and should consider one or more occupations that will fit these qualities.

6. Occupational Requirements

Occupations, like people, have many varied characteristics. Occupations that appeal to a person should be investigated as to their specific characteristics and examined in terms of what they have to offer and what the prospective employee can offer the occupation.

One can be much better prepared to plan a career if a study is made of the occupation and all facts are available. This is necessary in order to make a wise choice. The following discussion should be helpful in studying the various occupational requirements.

Transparency No. 3

Employment Outlook - The business trends that might affect future employment, current and future demands of employees in the occupation, and salary and other benefits should be determined. The local office of the State Employment Service should be able to provide this information. The above information is mailed to the state offices monthly by the U.S. Department of Labor.

Nature of Work - When considering possible career choices, it would be wise to become familiar with the nature of the work. A knowledge of the work performed will assist in comparing one occupation with another. The following questions pertaining to an occupation will assist in determining the nature of the work.

1. Work performed
   a. Physical activities performed?
   b. Tools and equipment used in occupation?
   c. Travel involved?
   d. Responsibilities that must be assumed?
2. Working conditions
   a. Environment in which work is performed?
   b. Exposure to hazardous or unpleasant working conditions?
   c. Whether work will be performed with others or alone?
   d. Supervision?
3. Working period or hours
   a. Regular or irregular hours?
   b. Shift, day, or night?

Qualifications - The occupational entrance requirements should be determined before making a career choice. A consideration of the following factors should be helpful in determining the entrance requirements:

1. Special aptitudes and interests required by occupations;
2. Educational level, training, and experience requirements;
3. Physical requirements; and
4. Personality characteristics required.

Entrance and Advancement - The occupational choice normally influences the state and area within a state in which one will live. After determining the areas in which one would seek employment, then the methods used to enter and advance in the occupation should be determined. Some employees are hired directly by the employer, while others are hired through employment agencies. Still others must have the approval of a labor union before becoming employed. It is important to be familiar with the procedure used.

In addition to determining the method for entrance, it is important to determine methods of advancement and requirements for advancement. Some jobs offer no advancement, while others offer many advancements.

Advancement usually depends upon a combination of factors such as size and type of business, personal qualities, interest in work, willingness to learn, and ability to get along with fellow employees. Most occupations provide advancement opportunities in the form of higher pay after the employee proves himself/herself by accepting more responsibility and performing a greater variety of tasks. The following transparency should be helpful in reviewing the requirements of an occupation.

Chart No. 2

PERSONAL INVENTORY FORM

Personal Data:

Name ______________________________ Social Sec. No. __________

Address ______________________________ Phone No. __________

Age ________ Sex ________ Height ________ Weight ________ Birth Date ________

Name of Father ____________________ Occupation ____________________

Name of Mother ____________________ Occupation ____________________

Do you live at home? ________ If not, where? ________ Are you married? ________

Church Preference ________________ Military Status ____________________

Educational Background:

High School Attended ______________________ Grade Now __________

Rank in Class ______________________ List school subjects that
(Above average, Average, Below average)

you have completed: ______________________________

____

____

What subjects did you enjoy most? ______________________________

____________. Least? ______________________________

List school activity participation by years: ______________________________

____

List school clubs and offices held: ______________________________

____

How many years of vocational agriculture have you taken? __________

What other classes would be helpful for preparation for employment? __________

____

List specialized training received in school: ______________________________

Number of days absent from school or work? ______________________________

Work Experience:

List the names of all previous employers, the length of time worked for each, and the reason for leaving: ______________________________

____

____

PERSONAL INVENTORY FORM (Continued)

Health:

List any serious illness or operation that you have had: ______________________

____

Were you physically handicapped? __________ Explain: ______________________

__________________ Were you ever injured while working? __________ Explain:

____

Name of family physician: ______________________

Person to notify in case of emergency: ______________________

Hobbies and Recreation:

List hobbies or recreational activities that you enjoy: ______________________

____

References:

List the names & addresses of three people whom you might use as a reference. Do not include relatives. (Use teachers, ministers, employers.)

______________________ ______________________

______________________ ______________________

______________________ ______________________

Other information:

What do you think are your qualifications for becoming employed? ______________

____

What are your ambitions? ______________________

____

____

Occupational Requirements

1. Place of employment ______________________________
2. Employment outlook
    - A. Present need for workers?
        - (1) Locally -
        - (2) In state -
    - B. Future outlook? ______________________________
    - C. Employee turnover? ______________________________
3. Nature of work
    - A. Activities, duties, and responsibilities ______________________________
      ____
    - B. Working conditions ______________________________
      ____
    - C. Working hours ______________________________
4. Qualifications
    - A. Mental abilities
        - (1) Language skills ______________________________
        - (2) Writing skills ______________________________
        - (3) Mathematical skills ______________________________
    - B. Educational and training requirements ______________________________
        - (1) Location ______________________________
        - (2) Cost ______________________________
    - C. Physical requirements
        - (1) Health ______________________________
        - (2) Strength ______________________________
    - D. Personal characteristics
      ____
5. Entrance and advancement
    - A. Certification or License ______________________________
    - B. Union membership, professional societies ______________________________
    - C. Salary ______________________________
    - D. Promotion, security, benefits ______________________________

CONSEQUENCES OF AN OCCUPATIONAL CHOICE

THE OCCUPATIONAL CHOICE MAY DETERMINE:

- WHETHER A PERSON IS EMPLOYED, UNDEREMPLOYED, OR UNEMPLOYED.
- A PERSON'S ASSOCIATES.
- SUCCESS OR FAILURE.
- WHETHER ONE LIKES OR DISLIKES HIS WORK.
- A PERSON'S CONTRIBUTION TO SOCIETY.
- AREA IN WHICH ONE LIVES.
- CHOICE OF FRIENDS.
- MARRIAGE PARTNER.
- SCHOOL WHICH CHILDREN WILL ATTEND.
- PHYSICAL & MENTAL HEALTH.
- SALARY.
- VISITS TO OTHER FAMILY MEMBERS.

PERSONAL QUALITIES & THE WORLD OF WORK

- ability
- talents
- interests
- physical make-up
- educational aspirations
- attitudes and values
- personality
- self concept
- willingness to change
- previous experience

FACTORS TO CONSIDER IN DETERMINING OCCUPATIONAL REQUIREMENTS

employment outlook

trends, current and future demand for employees, salary, and other benefits

nature of work

work performed

physical activities, tools and equipment used, travel involved, and responsibilities

working conditions

environment, exposure to hazards, etc., work performed with others or alone, and supervision

working hours

regular or irregular hours, shift work, day or night work

qualifications

special aptitudes and interests; education, training and experience; physical; and personal characteristics

entrance and advancement

CVAE AND VEH HORTICULTURE

Unite A: Opportunities in Horticultural Occupations

Topic 4: Finding a Job and Preparing for an Interview

Suggested Procedures and Activities:

After completing the topic it is suggested that the letter, "Why the Other Boy was Hired" and the discussion on the boy who recommended himself be read to the class. These are at the end of the topic.

1. Finding a Job

Most employed individuals at sometime during their working years must seek a place of employment. "Job hunting" is a form of selling. The person applying for a job is selling skills or services. Competition for jobs is keen, and the salesperson having the most to offer is usually the one that is successful.

Studies have been conducted to determine the best methods of finding job vacancies. The following information is based on these studies:

Relatives and Friends - Successful job applicants are notified of job openings about 50 percent of the time by their relatives and friends. Many times jobs are filled by this method before the job opening is advertised or reported to the employment agency. However, equal opportunity employers (employers having non-discriminatory practices in the hiring, assigning, promoting, paying, etc.) are required to advertise job openings for a minimum length of time, which is generally two weeks.

Those looking for jobs should notify their friends and relatives that they are seeking employment. The job seeker, however, should not expect his friends and relatives to use their influence, or misrepresent the applicant's abilities and skills. The hiring of employees is an expense to the employer. Hiring of an incapable person increases expenses and causes a loss of confidence for relatives and friends.

Personal Contacts - This is the second most effective method of finding a job. To use this method, several firms are selected that are presently using skills and services comparable to those of the job seeker. Contact is made with the firm by either appearing in person or telephoning the firm's employment office.

Newspapers - Most all newspapers have a section with the heading, Job Opportunities. Many of the advertisements give a detailed description of the type of individuals the firm is hiring. The job seeker should be aware that the sooner the contact is made--

whether by letter, telephone, or personal contact--the better are the chances of obtaining the job. Another method of using the newspaper is to place an advertisement in the Situation Wanted section. When using this method, the applicant should be easily contacted by the prospective employer.

Contacts with Former Employers - This is often a good method of seeking employment if the job seeker performed well when employed by the firm and the termination of employment was amiable. This method is effective many times when no vacancy or job opportunity actually exists. The employer creates a position for the employer.

Employment Agency - The term "employment agency" is not restricted to the state employment service and includes the local school counseling service, community employment organizations, and private employment services. These agencies usually have trained placement personnel to assist the job seeker.

2. Letter of Application

Letters of application are useful both to the job seeker and to the employer. It is often used by the job seeker to determine if firms have job openings.

Employers use letters of application in several ways, some of which are to gain insight as to the ability of the applicant to express himself/herself in written form; to schedule interviews; to obtain background information as to the applicant's training, experiences, and qualifications; and as a means of selecting applicants to interview.

The importance of the letter of application cannot be over emphasized. Some situations in which letters should be written are as follows:

1. When applying for a business or professional position out of town;
2. When seeking an interview;
3. When answering a newspaper advertisement that requests a written application; and
4. When an employer requests a letter of application.

Since the letter of application is a means of selling one's self to an employer, it is necessary to create a good impression. The following should be helpful in composing the letter:

1. If possible, the letter should be written to a specific person and not merely to the firm.
2. All names should be spelled correctly. If necessary, a telephone call should be made to verify spelling.
3. The letter should be brief, original, and "to the point."
   a. Introductory remark in the letter should state the exact position or type

of position the applicant is seeking.
  - b. Details about ability and background are omitted. These are left for the interview. An accompanying outline of details (personal data sheet) is permissible.

4. The letter is typed or neatly written. A pencil is never used. Limit letter to one typewritten page, and compose short paragraphs.
5. Standard size paper (8½ inches by 11 inches) is used.
   - a. Avoid erasures and write on only one side.
   - b. Letterhead stationery is not used unless it is the applicant's.
6. Correct spelling and punctuation is a must.
7. The closing paragraph should be effective.
   - a. A statement that the applicant would be glad to appear for an interview at the employer's convenience should be included.
   - b. A business-like closing is used.

Personal Data Sheet

A well-written letter of application may be all that is necessary to secure an interview. It may, however, be an advantage for the applicant to include additional information on a personal data sheet. This is the accepted way of presenting information not included in the letter of application. The personal data sheet might include a picture, information pertaining to family members, physical stature and general health, courses taken in school, work experience, performance skills, hobbies, and references.

Written Application Forms

Applicants applying in person are normally asked to complete an application form. The usual practice, however, is to submit a written application form before the interview is scheduled. A copy of the applicant's personal data will be helpful in completing the application form. Also, the applicant should have at least three references. Permission should be obtained in advance to use the references. The job seeker should be aware that the employer will form an opinion of the applicant's neatness and ability to complete the form.

The following should be helpful in completing an application form:

1. Follow instructions. The form usually has instructions as to whether the applicant should write or print and use pencil or pen.
2. Write or print neatly and legibly. Keep form clean and free of erasures.
3. All questions are not applicable; the letters NA should be written in the space provided.
4. Questions should be understood before attempting to answer them.
5. Personal data sheet is used to complete application form.

Chart Nos. 1 and 2

3. Preparing for the Interview

The purpose of an interview is to verify the information in the application and to gain insight into the prospective employee. Personality, mannerisms, attitude, ambition, career plans, education, and work experience can be observed and verified. Detailed preparations for the interview should be made, since the time spent in the interview is some of the most valuable time the applicant will spend in securing a job.

The first impression is generally a lasting impression. The person being interviewed must make a favorable impression because there is only one personal interview. Much of the success or failure in securing the position is dependent upon the interview.

Personal interviews may be compared to selling. A good salesperson not only has a knowledge of her/his products but of competitive products. Questions can be answered about the products without hesitation. It is necessary, like a good salesperson, that the applicant be able to answer any personal question, either orally or in writing. Since the applicant is trying to sell a product, service, or skills, a knowledge of service and skills that can be rendered is important.

Product knowledge for the prospective employee may be secured by preparing a personal inventory. An example of a personal inventory form is provided in the topic, "Choosing an Occupation." Although the inventory will not be presented to the employer, it should be written in order that the applicant can review and study it.

After studying the personal inventory, the applicant may discover that he/she does not have the qualifications for the position. It is necessary to have the skills and competencies needed to perform the job for which one is applying.

Prior to the interview, the applicant should gather as much information as possible about the employer or firm. The locations of plants, kinds of products sold or manufactured, growth trends, and employment opportunities available are some facts that should be secured. This information is important regardless of the size of the firm. One method of securing this type of information would be from an employee of the firm.

The following are often asked during on interview and may be helpful in preparing for the interview:

1. What are your long range and short range goals and objectives, when and how did you establish these goals, and how are you preparing yourself to achieve them?
2. What specific goals other than those related to your occupation have you established?

3. Why would you like to work for our company?
4. What do you know about our company?
5. What qualifications or training do you have for this job?
6. What do you see yourself doing five years from now?
7. What are the most important rewards you expect in your career?
8. What do you expect to be earning in five years?
9. Do you feel that you have done the best scholastic work that you are capable of doing?
10. In what activities and clubs were you involved while in high school?
11. How many days were you absent from school or work because of illness?
12. Have you had any serious illness?
13. Do you smoke?
14. Do you drink alcoholic beverages?
15. Do you like routine work?
16. Do you like regular hours of work?
17. How do you feel about working overtime?
18. Do you prefer a specific geographic location?
19. Will you relocate? Does relocation bother you?
20. Are you willing to travel?
21. Are you willing to spend at least six months as a trainee?
22. What salary do you expect?
23. Have you had any difficulty getting along with fellow students and instructors?
24. What is your major weakness?
25. What major problems have you encountered and how did you deal with it?
26. What have you learned from your mistakes?
27. What two or three accomplishments have given you the most satisfaction? Why?
28. Describe the relationship that should exist between a supervisor and those reporting to him or her.
29. What qualities should a successful manager possess?
30. How do you determine or evaluate success?
31. In what way do you think you can make a contribution to our company?
32. How do you spend your leisure time?
33. What are your hobbies?

Some factors that one might consider in preparing for the interview and in creating a good impression on the day of the interview are as follows:

Things Needed During Interview - Pen and pencil, social security card, personal data sheet, personal inventory, and certification or work permit, if required, should be carried to the interview.

Exclusion - The applicant should go alone for the interview. Most employers resent persons applying in a group, or with another person, such as a parent, sitting in during the interview.

Physical and Mental Appearance - The employer's first impression will be based on the applicant's appearance. The applicant should be neatly dressed but not over-dressed for the job being sought. For some interviews, the male applicant should wear a coat and tie, while for others an open shirt collar is proper. A female applicant in most instances should use "good taste" and dress reasonably conservative. Both males and females should be well-groomed and should refrain from smoking during the interview, unless the employer suggests that the applicant smoke.

Promptness - A good salesperson is on time for an appointment and does not keep the customer, or the employer in this case, waiting. A tardy applicant creates an unfavorable impression. If it is necessary to drive some distance for the interview, ample time should be allowed. The applicant also should not be too early. Arriving five to ten minutes before the scheduled time is considered to be adequate.

Office Manners - Many employers have secretaries or receptionists, and it will be necessary to spend a few minutes in their office before the interview. The applicant should introduce himself/herself to the secretary and tell her the purpose of the visit (for an interview) and that the applicant would like to see the employer when it is convenient. The applicant should also try to favorably impress the secretary. Some secretaries have considerable clout with their employers.

Entering the Employer's Office - If not introduced to the employer by the secretary, then the applicant should introduce himself/herself in a pleasant businesslike manner. The interviewee's name is pronounced distinctly, and the applicant should not use Mr. or Mrs. in his/her introduction. If the employer offers to shake hands, the applicant should do so with a firm grip. The applicant should wait for an invitation to be seated before sitting down and should observe good posture while seated.

The Interview - Some interviews are informal and chatty and are nothing more than the employer observing the applicant's appearance and mannerisms. Still others may require considerable time and may involve the taking of tests to determine aptitudes and abilities.

After the applicant has been introduced, the interviewer is allowed to take the lead in asking questions and directing the course of the conversation. The interviewer is aware of the information needed. The first question or statement may concern information regarding the requirements of the job. The applicant's response should be brief, meaningful, and provide only information requested, unless an interest in additional information is indicated. Time should not be used by the applicant relating favorable information not related to the job. If the interviewer requests the applicant's personal folder, it should be provided; but the applicant should not shower the interviewer with documents on experiences and qualifications.

The applicant should be truthful, direct, and use proper English when answering questions. Slang is avoided. Qualifications are being sold, rather than a need for work. The interviewer is interested in what the applicant can do rather than how badly work is needed. Initiative should be shown, rather than the applicant's concern for salary and other employee benefits. The applicant should not tell jokes or be overly friendly, but should be agreeable and act as one would normally. Any papers on the desk belong to the interviewer and no attempt should be made to read them.

Some questions during the interview may be intentionally personal and blunt in order to test the applicant's reaction and tact. Other questions may be asked to determine social or moral attitudes, as well as concerning job knowledge. If a matter of a controversial nature is discussed, the best policy is to answer briefly without showing emotions or giving a strong personal opinion either way. Normally, a good rule to follow if a pleasant statement cannot be made about a situation or topics is to say very little or nothing. This is particularly true if the subject pertains to school or a former employer. If it becomes necessary to explain a situation that is not totally desirable, the applicant should avoid saying anything that will appear to be a complaint.

The interviewer should end the interview; however, if there are points of interest concerning working hours or other specific information that have been overlooked, the applicant should feel free to ask questions. It is a good idea not to appear overly anxious, but in order to make an intelligent decision, it is necessary that the applicant be well-informed. Most interviewers encourage applicants to ask questions concerning the firm and its policies. These are sometimes left to near the end of the interview.

The applicant should be alert in determining the close of the interview and should leave as soon as it is completed. It is proper at the close to express appreciation for the time and consideration given.

Some mention of future contact is usually made by the interviewer. If this is not mentioned, the applicant may ask if a future contact will be made, in what manner, and how.

It is not a common practice to offer the applicant the job during the interview because the interviewer may wish to interview other applicants or check references. However, the applicant may be offered the job during the interview.

It is proper for the applicant to follow-up on jobs that appear encouraging. This is accomplished by writing a note of appreciation to the interviewer. The note will serve as a reminder of the interview.

The applicant should not be disappointed if the impression desired is not made during the interview. The best salesperson does not make every sale. An interview with another firm should be scheduled, and the applicant should learn from any mistakes made during the previous interview. A better impression should be made at the next interview. The following rating sheet could be useful in evaluating an interview.

Chart No. 3

Most large firms employ full-time personnel managers and assistants who have the responsibility of hiring new employees. These firms are constantly seeking new employees. However, the firms expect the prospective employee to seek the job. One should not be reluctant to apply for a position that appears to be desirable; that is, if the applicant has the qualifications.

4. Letter, Why the Other Boy was Hired

The following letter was writen by Donald E. Wood to a teenage boy who applied for a job. It is included to help prospective employees see how some employers look at young job applicants.

Dear Kid:

Today you asked me for a job. From the look of your shoulders as you walked out, I suspect you've been turned down before, and maybe you believe by now that kids out of high school can't find work.

But, I hired a teenager today. You saw him. He was the one with polished shoes and a necktie. What was so special about him? Not experience, neither of you had any. It was his attitude that put him on the payroll instead of you. Attitude, son. A-T-T-I-T-U-D-E. He wanted that job badly enough to shuck the leather jacket, get a haircut, and look in the telephone book to find out what this company makes. He did his best to impress me. That's where he edged you out.

You see, Kid, people who hire people aren't "with" a lot of things. We know more about Bing than about Ringo, and we have some Stone-Age ideas about who owes whom a living. Maybe that makes us prehistoric, but there's nothing wrong with the checks we sign, and if you want one you'd better tune to our wave length.

Ever hear of "empathy?" It's the trick of seeing the other fellow's side of things. I couldn't have cared less that you're behind in your car payments. That's your problem. What I needed was someone who'd go out in the plant, keep his eyes open, and work for me like he'd work for himself. If you have even the vaguest idea of what I'm trying to say, let it show the next time you ask for a job. You'll be head and shoulders over the rest.

Look Kid: The only time jobs grew on trees was while most of the manpower was wearing G.I.'s and pulling K.P. For all the rest of history you've had to get a job like you get a girl: "Case" the situation, wear a clean shirt, and try to appear reasonably willing.

Maybe jobs aren't as plentiful right now, but a lot of us can remember when master craftsmen walked the streets. By comparison you don't know the meaning of "scarce."

You may not believe it, but all around you employers are looking for young men smart enough to go after a job in the old-fashioned way. When they find one, they can't wait to unload some of their worries on him.

For both our sakes, get eager, will you?

Donald E. Wood

5. The Boy Who Recommended Himself

A gentleman advertised for a boy to assist him in his office, and nearly fifty applicants presented themselves. Out of the number, he selected one and dismissed the rest.

"I should like to know," said a friend, "on what grounds you selected that boy, who had not a single recommendation."

"You are mistaken," said the gentleman. "He had a great many. He wiped his feet when he came in, and closed the door after him, showing that he was careful. He gave his seat, instantly, to that lame old man, showing that he was kind and thoughtful. He took his hat off when he came in and answered my questions promptly, showing that he was polite and gentlemanly. He picked up the book which I had purposely laid on the floor and replaced it upon the table, while all the rest stepped over it, showing that he was orderly. He waited quietly for his turn, instead of pushing and crowding. While I talked to him I noticed that his clothing was tidy, his hair neatly brushed, and his finger nails clean. Do you not call these things recommendations? I do."

This story was taken from a book by George W. Gerwig entitled, "Ambition-Guideposts to Character," published by the American Book Company, New York.

Reference:

"Group Instruction Handbook," Vocational Instructional Services, Texas A&M University, College Station, TX 1975.

SAMPLE LETTER OF APPLICATION

BOX 100
FARMVILLE, U.S.A.
SEPTEMBER 20, 1972

MR. JOHN MCAHEE, MANAGER
BROWN FARM IMPLEMENT COMPANY
340 MAIN STREET
FARMVILLE, U.S.A.

DEAR MR. MCAHEE:

MR. ANDREWS, TEACHER OF VOCATIONAL AGRICULTURE AT FARMVILLE HIGH SCHOOL, HAS INFORMED ME OF A VACANCY IN THE TRACTOR AND MACHINERY PARTS DEPARTMENT OF YOUR FIRM. I WOULD LIKE TO SUBMIT MY NAME FOR CONSIDERATION FOR THIS POSITION.

AT PRESENT, I AM A SENIOR ENROLLED IN THE COOPERATIVE PART-TIME TRAINING PROGRAM AT FARMVILLE HIGH SCHOOL AND WILL BE AVAILABLE FOR EMPLOYMENT AFTER 2:00 P.M. ON SCHOOL DAYS, AND THE ENTIRE DAY ON SATURDAYS AND DURING THE SUMMER.

I HAVE LIVED AND WORKED ON A FARM ALL MY LIFE. LAST SUMMER I WORKED IN THE PARTS DIVISION OF THE FARMVILLE TRACTOR AND EQUIPMENT COMPANY. I HAVE SERVED AS SECRETARY OF THE LOCAL FFA CHAPTER AND RANK SCHOLASTICALLY IN THE UPPER FOURTH OF MY HIGH SCHOOL CLASS.

I AM INTERESTED IN A CAREER IN AGRICULTURAL MACHINERY SALES AND RECOGNIZE THE VALUE OF BEING ASSOCIATED WITH A FIRM OF YOUR REPUTATION. I WOULD APPRECIATE A PERSONAL INTERVIEW WITH YOU AT YOUR EARLIEST CONVENIENCE SO YOU MAY BECOME BETTER ACQUAINTED WITH MY QUALIFICATION I WILL BE AVAILABLE FOR AN INTERVIEW AFTER 2:00 P.M. ON SCHOOL DAYS AND ANY TIME ON SATURDAYS.

I MAY BE CONTACTED AT THE ABOVE ADDRESS OR THROUGH MR. ANDREWS AT THE HIGH SCHOOL. I AM LOOKING FORWARD TO YOUR REPLY.

SINCERELY,

JOHN JONES

PERSONAL DATA

Name ______________________ Soc. Sec. No. ____________

Address ______________________ Res. Telephone ____________

______________________ Bus. or Sch. Telephone ________

Age ____________ Date of Birth: ______________________

(Month/Day/Year)

Health

Family physician ____________ Your Height ________ Weight ________

List illnesses or operations in recent years ______________________

____

List physical handicaps ______________________

Describe ______________________

Education

	Name of School	City	Dates Attended	Date Graduated
Elementary				
High School				
Trade School				
Other				

Hobbies

____

Extracurricular Activities

____

____

References

	Name of Person or Firm	Address	Telephone No.
1.			
2.			
3.			

Work Experience

Name of Firm	Address	Dates of Employment

RATING SHEET FOR PERSONAL INTERVIEW

Name ______________________________ Job Applied For __________________

Check the answer which you think is most appropriate for the following questions:

YES NO

1. Arrived on time
2. Introduced himself properly (stood erect and looked interviewer in the eye during introduction)
3. Waited for invitation to be seated
4. Answered questions clearly and concisely
5. Had all proper credentials (social security card, personal data sheet, work permit -- if applicable)
6. Was generally familiar with the company (wage scale, nature of work, reputation of the company, competition in the field, etc.)
7. Asked pertinent questions about the company
8. Used reasonably good English

(Check one)	Above Average	Average	Below Average
1. Appearance	____________	____________	____________
2. Interest	____________	____________	____________
3. Maturity	____________	____________	____________
4. Anticipated competence	____________	____________	____________
5. Attitude			

Comments:

Recommendations:

1. __________ Hire
2. __________ No Interest
3. No interest, suggest interview with ______________________________

Evaluator ______________________________ ______________________
(Signature) (Date)

A-4
Chart No. 3

CVAE AND VEH HORTICULTURE

Unit A: Opportunities in Horticultural Occupations

Topic 5: Employee - Employee and Employee - Employer Relations

Suggested Procedure and Activities:

While discussing this topic, use actual case situations in the class. Community employers and employees may also be used as resource speakers.

1. Introduction

The degree of success attained by a worker on the job is largely dependent upon three things: the ability to skillfully perform job duties; the possession of certain knowledge and understandings; and the ability to get along well with people contacted on the job. On the part of the employee, skills and knowledge are important, but cannot overcome the handicap of poor personal relations. By the same token, employers who ignore the principles of good personal relations are plagued with disgruntled workers and usually have a high rate of labor turnover. A good on-the-job relationship is a two-way affair requiring thoughtfulness, consideration, and fair play on every hand.

Transparency No. 1

2. Facts Concerning Employee-Employee Relations

1. Most occupations deal with machines, equipment, or paper work; that is, they deal with things. In business, however, most of the jobs involve close contact with people.

2. As a group, people are very much different. Each person is an individual. It is possible for things that appeal to one person to be distasteful to others.

3. Three things people have in common are: right to work at a job of own choice; desire to get ahead; and desire to be accepted and approved of.

4. Routine duties should be performed along with the so called "important jobs" to the best ability of the worker. Along with doing a job well, it is important to learn as much as possible about the total business operation.

5. An employee should exhibit the following traits: tact, sense of humor, initiative, enthusiasm, team spirit, loyalty, ability to take constructive criticism, and respect for other individuals.

6. The total morale of a business operation is not up to the boss alone; it depends upon each individual employee.

7. A desirable employee will avoid joining a clique, be willing to learn, and show appreciation to fellow workers.

8. The primary objective of all employees is to make a living. But in addition to this, there are other satisfactions in a job. These might be social status or psychological needs. All employees like to feel that their job is important.

3. Responsibilities of the Employer to the Employee

Transparency No. 2

1. The employer provides a place to work and, in most cases, equipment to work with. This often includes land, facilities, tools, and equipment which require a sizable investment.

2. An employer does not expect a new worker to be fully productive until he or she has been trained for the job. The employer usually loses money while a beginner is being trained. The employer may invest many more dollars in training an enterprising worker for a supervisory position.

3. An employer should provide pleasant surroundings in which to work. In addition to providing adequate space and equipment, many employers provide food facilities or allowances and recreational activities for their employees.

4. The employer is responsible for salaries and other financial benefits. These may include various forms of insurance (medical, life, accident, unemployment), advancement, retirement plans, holidays and vacations, discounts on purchases, and handling of income tax and social security accounts.

4. Responsibilities of the Employee to the Employer

Transparency No. 3

Employers expect cooperation and dependability from employees in return for salaries and benefits. The following attitudes and characteristics are expected on the part of the employee:

1. Honesty means more than just not taking things which do not belong to one. It means giving a fair day's work for a fair day's pay or carrying out one's side of a bargain. Honesty also dictates that one's words convey true meanings and actual happenings.

2. Loyalty implies support of a cause, ideal, practice, or custom. It means being "for" a person or an organization, and that is a two-way proposition. Employees expect employers to look out for their interests, to provide them steady employment, and to promote them to better jobs as openings occur. Employers feel that they, too, have a right to expect their employees to be "for" them-to keep their interests in mind, to speak well of them to others, to keep any minor troubles strictly within the plant or office, and to keep absolutely confidential all matters that pertain to the business. Perhaps both employers and employees should keep in mind that loyalty is not something to be demanded; rather, it is something to be deserved.

   Loyalty takes time to mature and grow. It is the product of continued contact with a person or business over a period of time. New employees should not expect to receive this loyalty before proving themselves worthy of their supervisor's faith and confidence. Likewise business firms must earn loyalty from their employees. The good will and loyalty which develop between supervisors and employees are valuable commodities, which are not to be treated lightly.

3. Willingness to Learn - Almost every different kind of agricultural business will have its own way of doing things. Employers expect their employees to be willing to learn these ways. Sometimes the installation or use of new equipment or machines make it necessary for even experienced employees to learn new methods and operations. It will be noted that workers who are promoted to jobs with greater responsibility are usually those who have taken the time and trouble to learn about more than just their own daily tasks.

4. Willingness to Take Responsibility - Most employers expect their employees to see what needs to be done, then go ahead and do it. It is very tiresome to have to ask again and again that a certain job be done. When an employee is given directions about how to do a job, then he is expected to follow them exactly. It is generally true that responsibility should be delegated and not assumed; however, once the responsibility has been delegated, the employee should continue to perform the duties without further direction.

5. Respect for Authority - Authority in agricultural businesses usually rests in managerial positions which are responsible for production, sales, or service, as the case may be.

   Authority is the power or right to give commands, take actions, or make final decisions.

   Most agricultural businesses are relatively small and uncomplicated. Yet, the concept of respecting your superior is an important one, even in a small business.

6. Ability to Get Along with People - This is perhaps the most highly prized of all employee traits. To some ability to get along well with people seems to come as a gift; to others, it comes only as a result of painstaking thought and training. In order to acquire this ability, one must learn to think of people as individuals, to be able at times to put oneself in another person's place, and to want sincerely to get along with others. Once acquired, the ability to get along well with people pays big dividends in friendships, popularity, and profits. Employers are ever appreciative of the employee who is "easy to get along with."

7. Willingness to Cooperate - The employer who pays the salary has a right to expect full cooperation of the employee. One of the best ways to show a cooperative attitude is to offer to help other employees when one's assigned duites have been completed. In many companies there are certain tasks that nobody likes to do. The employee who is willing to do these tasks will make a good impression on the boss and also gain the cooperation of fellow workers. One should learn to work as a member of a team with employer, supervisors, and fellow workers in a common effort to get the work done pleasantly and on time.

8. Rules and Regulations - Not even two people can work together well unless there is some understanding as to what work shall be done, when it is to be done, and who shall do it. Rules and regulations are a necessity in any work situation, and should be so considered by all employees.

9. Tardiness and Absenteeism - Tardiness means being late to work, and absenteeism means being off the job for one reason or another. Both are poor work habits and lead to reduced production. Failure to get to work on time results in confusion, lost time, resentment on the part of those who do come on time, and may lead to a reprimand or even a dismissal. It is true that a few minutes out of a day is not important, but a principle is involved. The employee agrees to terms and conditions when accepting a job.

   It is sometimes necessary to take time off from work. No one should be expected to work when sick, or when there is serious trouble at home which demands attention. However, it is possible to get into the habit of letting unimportant and unnecessary matters come before the job. This results in lost production and hardship on those who try to carry on the work with less help. Again there is a principle involved. The employer has a right to expect employees to be on the job unless there is some very good reason for staying away. If it is necessary for an employee to miss work, it is the responsibility of that person to notify the employer or supervisor.

10. Termination of Employment - Legally and rightfully there are several ways in which relations between employer and employee may be terminated. In many cases the condition of employment is set forth in a contract signed by the worker or his representative and the employer.

When employment is based upon contracted relation, then both employer and employee are bound by the same laws that validate any contract. Should either employer or employee take the liberty of breaking the contract that exists, it makes the guilty party liable to the offended party.

There exists in the present employer-employee relations an "unwritten law," sometimes called "gentlemen's agreement," which deals with the termination of employer-employee relations. This is called "due notice" to employer by employee, and "due notice" to employee by employer. Most employment today is based upon the "unwritten law." This tends to serve the following purposes: (1) it does not bind an employee for a long period of time to a job for which he has no interest or ability; (2) it does not force an employer to continue to pay an employee whose services are detrimental to his business; (3) it allows both employer and employee time to make adjustments before termination without jeopardizing either; and (4) it serves as a means of keeping both employer and employee respectful and honest with each other.

From the employer's standpoint an employee may be discharged from his job even though there might exist between the two a legal contract. The following acts are reasons for justifiable discharge on the part of the employer: willful disobedience, disloyalty, incompetency, and nonperformance.

5. Employee Self-Evaluation

Feelings and attitudes between persons affect the productivity of the employee group. One employee who is not satisfied may influence others. Undesirable influence may spread through the entire group.

It is probably true that most people want to get along well with others, but don't really know how. The following are self-evaluation questions an employee may ask:

1. Am I willing to help the other fellow?
2. Am I willing to go halfway to be friendly?
3. Do I become irritable or show annoyance when changes or mistakes occur?
4. Do I try to be fair?
5. Do I hold grudges?
6. Do I give the other fellow the benefit of the doubt?
7. Do I talk more about the good than the bad qualities of others?
8. Do I think only of my own interests?

9. Do I take myself or my work too seriously?

10. Do I value my own integrity (character)?

11. Can I take authority?

Reference:

"Group Instruction Handbook, Cooperative Part-Time Training", Vocational Instructional Services, Texas A&M University, 1975.

EMPLOYEE-EMPLOYER RELATIONS

- be tactful
- keep sense of humor
- show initiative
- have enthusiasm
- have team spirit
- be loyal
- take constructive criticism
- have respect for other individuals

RESPONSIBILITIES OF THE EMPLOYER

- provide place to work
- provide equipment to work with
- provide training
- provide pleasant atmosphere
- provide salary
- provide benefits

RESPONSIBILITIES OF THE EMPLOYEE

- be honest
- be loyal
- be willing to learn
- be willing to take responsibility
- respect for authority
- ability to get along with people
- be willing to cooperate
- follow rules and regulations
- be on time for work
- avoid absenteeism
- fulfill contract or work agreement

CVAE AND VEH HORTICULTURE

Unit A: Opportunities in Horticultural Occupations

Topic 6: Employee Benefits and Payroll Information

Suggested Procedure and Activities:

A comparative study of horticultural occupations can be made using community and surrounding area resources and actual case situations.

1. Introduction

Job benefits and privileges have been expanded by most employers; therefore, these considerations are important in job selection. The individual seeking employment should calculate the value of benefits and privileges. In most instances, they are figured as a part of the total cost of employment along with salary. Most benefits and privileges are due to the fact that the employer and employee jointly finance the cost by payroll deduction on the part of the employee and contribution on the part of the employer.

The location of employment, the work schedule, the working conditions, and the salary are primary considerations in job selection. Job seekers must match themselves with opportunities available. Benefits and privileges are to be considered in the final selection of a job. School counselors, teachers, parents, and friends can offer sound advice to young people entering the job market. Salaries paid to workers depend upon state and federal minimum wage laws, the "going rate" for the type of job, and the ability of the worker to perform the job. Part-time and beginning workers cannot expect to earn as much salary or enjoy the same benefits as the experienced full-time employee.

Transparency No. 1

It is important that employees understand the cost and value of benefits available. These benefits and privileges include: insurance plans, retirement plans, social security programs, housing allowances, travel allowances, sick leave, vacation, and holidays.

2. Insurance Plans

Health insurance programs have three functions: (a) protect the insured against financial hardships due to illness or injury; (b) cover the cost of medical care in order to assure competent treatment; and (c) protect creditors by insuring the policy holder's ability to repay debts. Health insurance is commonly divided into two coverage areas; the more frequent minor expenses and the less frequent major expenses. The prospective insurance buyer must decide which of the two areas, or both, to insure against. The basic health plan usually covers hospital, surgical, and physician's services up to a determined amount. The major medical plan is designed to take up where the basic plan left off. It is designed to handle large medical expenses, up to one million dollars in some cases. The major medical plan usually has a deductible amount to be satisfied and then will pay a percentage of the remaining cost.

Disability income insurance plans offer protection against salary loss as a result of sickness or accident, with varying amounts of annual benefit. The varying amount is up to seventy-five percent of an employee's earnings.

Life insurance is unique in that it treats each person's eventual death as "risk". Even though death is a certainty, when it will occur is not known. Life insurance works because the cost of one person's death and the resultant expenses incurred are distributed to a large number of persons. There are two basic reasons for owning life insurance: (a) provides protection against loss of income due to the premature death of the breadwinner and (b) allows for systematic savings and investment.

The first concern of life insurance is family protection in case of the untimely death of the head of the household. Certain expenses must be paid in connection with any death. These might include medical bills, burial expenses, settlement of debts, estate settlements, or even finding a new place to live.

The second concern of life insurance is to provide money for retirement in later years or for education of children. A life insurance program should be selected that will provide both death benefits and living benefits.

3. Retirement Plans

Retirement plans are usually based on age, years of service, and the salary drawn by the employee. Retirement plans which are totally financed by the employer usually terminate when the employee leaves the employer. On the other hand, some plans which provide for both parties sharing will return to the employee all contributions, together with interest which was earned during the period. Most retirement plans specify a minimum number of years of service and minimum age before an employee is eligible for retirement.

An example formula for a retirement plan is as follows: a worker who retired at age 65 with 42 years of service and an average salary for 5 years of $10,000 earns retirement benefits as indicated.

Transparency No. 2

$10,000	x	2%	x	42 years =	$8,400
Average of 5 years Highest Salary		Percent Average Salary		Years of Service	Annual Retirement Payment

The benefits are usually paid on a monthly basis and would in this case be $700 per month.

4. Social Security

Social security is the nation's basic method of providing a continuing income when family earnings are reduced or stop because of retirement, disability, or death. Today, ninety percent of the workers in the United States are earning protection under social security, and one out of seven persons are receiving monthly social security checks. About 22.8 million people, age 65 and over, have health insurance under Medicare. Another 2.6 million disabled people under 65 also have Medicare.

Social security benefits under the Federal act passed in 1935, and as amended since, provide coverage for industrial workers, self-employed persons, most state and local employees, members of the Armed Forces, members of the clergy, and household and farm employees. A farm employee is covered by the Social Security Act if an employer pays him $150 or more in cash wages during the calendar year for agricultural labor. The law also covers a farm employee who performs agricultural labor for an employer for twenty or more days during the year for cash wages figured on a time basis.

Monthly social security checks may go to workers and their dependents when the worker retires, becomes severely disabled, or dies. Medicare helps to pay the cost of health care for eligible people who are 65 or over or disabled.

A worker may receive retirement benefits as early as age 62, but at a reduced rate.

Disability benefits may be obtained before age 65 if the worker has a physical or mental condition that will prevent him from working for at least 12 months, or is expected to result in death.

Survivor benefits go to certain members of the worker's family. A lump-sum payment also can be made when a worker dies. This payment usually goes to the widow or widower. Unmarried dependent children are also eligible for survivor benefits.

Medicare has two parts - hospital insurance and medical insurances. The hospital insurance helps pay the cost of inpatient hospital care and certain types of followup care. The medical insurance part helps pay the cost of physicians' services and outpatient hospital services. People having the medical insurance pay a monthly premium of $8.20 as of July 1978.

Transparency No. 3

Employees and employers each contribute equal percentages on the employee's wages. Contribution rates and limits are scheduled as shown here:

1978 - 6.05 percent on earnings up to $17,700
1979 - 6.13 percent on earnings up to $22,900
1980 - 6.13 percent on earnings up to $25,900
1981 - 6.65 percent on earnings up to $29,700

Self-employed persons contribute on the same limit of earnings as do employers and employees. However, the percentage rate differs; in 1978 the self-employed person contributed 8.10 percent and in 1981 the rate will increase to 9.30 percent.

Transparency No. 4

In figuring monthly retirement checks, the retired or disabled person must meet eligibility requirements. The amount of the monthly check will depend upon several factors including age and average yearly earnings.

Examples of monthly social security payments are as follows:

(a) A retired worker age 65 with average yearly earnings covered by social security of $4000 would receive approximately $278.00.

(b) A retired worker age 62 with average yearly earnings covered by social security of $4000 would receive approximately $222.00.

5. Income Tax

Transparency No. 5

Income taxes are the largest source of Federal revenue. In 1977, 39¢ of each budget dollar received by the Federal government was from individual income taxes. The remainder of the budget dollar came for the following sources: 13¢ from corporation income taxes; 27¢ from social security taxes and contributions; 12¢ from borrowing; 4¢ from excise taxes; and 5¢ from other sources.

Transparency No. 6

Government revenue provides a wide range of services. The taxes an individual pays provide services which, in most cases, the individual could not afford. The following is a breakdown of how the Federal government budget dollar was spent in 1977: Income Security - 33½¢; National Defense - 24¢; Health - 10¢; International Affairs - 1½¢; General Science - 1¢; Natural Resources, Environment, and Energy - 3½¢; Agriculture - 1¢; Commerce and Transportation - 3½¢; Community and Regional Development - 2¢; Education, Training, and Social Services - 5¢; Veterans Benefits and Services - 4¢; Law Enforcement and Justice - 1¢; General Government - 1¢; Revenue Sharing - 2¢; and Net Interest - 7¢.

The income tax system in the U. S. is based on voluntary compliance; each person pays taxes and files a return. Income taxes are paid in the form of withholding taxes from employee's paychecks. Self-employed persons and others pay estimated taxes each quarter and/or annual taxes at the time their tax returns are filed.

An employee should complete Form W-4, Employee's Withholding Allowance Certificate, when starting a new job or at any time when exemptions change. Many students and part-time employees have no tax liabilities due to their income, and therefore should claim exemption from withholding taxes and no deduction for income tax will be taken from their pay checks.

Transparency No. 7

In 1977, the following chart was used to show the minimum amount of gross income to be received before being required to file a tax return:

Single	$2950
Single (age 65 or over)	$3700
Married filing a joint return	$4700
Married filing a joint return (one spouse age 65 or over)	$5450
Married filing a joint return (both spouses age 65 or over)	$6200
Married filing a separate return	$ 750
Surviving spouse with dependent child	$3950

In addition:

-Person receiving tips from which social security taxes were not withheld
-Self-employment income of $400 or more
-Gross income of $750 or more, had any unearned income, such as dividends or interest from savings accounts, and can be counted as a dependent by parents. This is particularly important to students.

April 15 is the due date on which most taxpayers must file their returns. The tax return should be mailed to the appropriate Internal Revenue Service Regional Office.

6. Fringe Benefits

Transparency No. 8

Additional benefits may be provided by the employer for the purpose of making employment more convenient and attractive to the employee. It should be understood that the additional benefits and privileges carry with them certain responsibilities. The following are common job fringe benefits:

(1) Housing Allowance - Allowances are sometime made for employees who are forced to move due to job requirements or transfer. In addition, some employers may furnish a house and utilities and possibly meat for family consumption.

(2) Travel Allowance - Allowances for travel are usually paid when employees are required to be away from their regular headquarters in order to perform assigned duties. The allowances include mileage for transportation, cost of meals, and cost of lodging. In addition, some employers may furnish a vehicle for use by employees.

(3) Sick Leave - Sick leave privileges are provided by the employer to protect the employee's salary during the time that illness prevents him from being on the job. Beginning employees usually receive basic sick leave days per month and the rate of accumulation is usually determined according to years of service.

(4) Vacation - Often referred to as annual leave for employees who enjoy their work but plan to be away from it periodically with their family and friends. This privilege actually means fewer work days per year. If the vacation time is paid, the employee not only gets a break from work but receives financial compensation.

(5) Holidays - Certain days during the year are set aside to commemorate historical events. Many employers allow employees time off with pay to celebrate these events.

References:

Atherton, J. C. and Mumphrey, A., Career Planning and Development, The Interstate Printers and Publishers, Inc., Danville, Illinois, 1969.

"Group Instruction Handbook, Cooperative Part-Time Training", Vocational Instructional Services, Texas A&M University, 1975.

"Your Social Security", HEW Publication No. (SSA) 78-10035, February 1978.

"Your Federal Income Tax", Publication 17, Internal Revenue Service, 1978 Edition.

"Understanding Taxes 78", Publication 21, Internal Revenue Service, 1978.

EMPLOYEE BENEFITS AND PAYROLL INFORMATION

- insurance
- retirement
- social security
- income tax
- housing allowance
- travel allowance
- sick leave
- vacation
- holidays

EXAMPLE RETIREMENT FORMULA

average of 5 years highest salary X per cent average salary X years of service = annual retirement payment

case situation: retired worker age 65
42 years of service
5 year average salary $ 10,000

$ 10,000 x 2% x 42 = $ 8,400

monthly retirement payment $ 700 (8,400÷12)

SOCIAL SECURITY RATES AND SALARY LIMITS

year	percentage	annual earnings up to -
1978	6.05	$17,700
1979	6.13	$22,900
1980	6.13	$25,900
1981	6.65	$29,700

EXAMPLES OF MONTHLY SOCIAL SECURITY PAYMENTS (effective June 1977)

benefits can be paid to a :	average yearly earnings after 1950 covered by social security		
	$3000	$5000	$8000
retired worker age 65	$236.40	$322.50	$453.10
spouse age 65	$118.20	$161.30	$226.60
spouse age 60 if sole survivor	$169.10	$230.60	$324.00
spouse with one child in care	$354.60	$483.80	$679.80

SOURCE OF 1977 FEDERAL BUDGET DOLLAR

individual income taxes	39¢
corporation income taxes	13¢
social security taxes	27¢
borrowing	12¢
excise taxes	4¢
other sources	5¢
total	$1.00

HOW THE 1977 GOVERNMENT DOLLAR WAS SPENT

income security	33½¢
national defense	24¢
health	10¢
international affairs	1½¢
general science	1¢
natural resources, environment, and energy	3½¢
agriculture	1¢
commerce and transportation	3½¢
community and regional development	2¢
education, training, and social services	5¢
veterans benefits and services	4¢
law enforcement and justice	1¢
general government	1¢
revenue sharing	2¢
net interest	7¢
total	$1.00

1977 INCOME TAX REQUIREMENTS

filing status	**gross income to be received before required to file return**
single	$2950
single(age 65 or over)	$3700
married filing joint return	$4700
married filing joint return (one spouse age 65 or over)	$5450
married filing joint return (both spouses age 65 or over)	$6200
married filing separate returns	$750
surviving spouse with dependent child	$3950

filing date : April 15

FRINGE BENEFITS

- housing allowance
- travel allowance
- sick leave
- vacation
- holidays

Vocational Instructional Services
Agricultural Education

B-1
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit B: Plant Classification and Identification

Topic 1: Classifying Plants to Identify Them

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

The teacher may wish to have the students start a collection of plant leaves as a laboratory exercise to supplement this topic. Attention is directed to the laboratory exercise at the end of topic C-2, which explains the procedure to use in making a leaf collection and using the plant information sheet.

1. Importance of Plant Identification

Knowledge is essential for one to be happy in a vocation. This is true in the horticultural industry as it is in other areas. The names of plants and the location in which they grow are part of the knowledge that must be acquired by those employed in a horticultural occupation. Some of the reasons why these are important are as follows:

1. Customers ask for plants by either name or description;
2. They are important for the performance of such tasks as moving a particular plant(s) from one growing area to another, filling customers' orders, loading delivery vehicles with specific plants, bringing plants from transporting vehicle to planting site, and removing weeds from flower beds or nursery fields;
3. In order to provide the proper growing environment and to carry out essential cultural practices; and
4. In order to properly control weeds in certain areas with herbicides.

The possibility of an employee being hired permanently is much greater if the above jobs can be performed with a minimum of supervision.

2. How Plants Get Their Names

In order to determine the origin, reproductive habits, and characteristics of plants and other living things, man uses a system of classification. This system makes it easier to study plants.

Students often question the value of learning the scientific (botanical) names of plants, but there are many advantages. Some are as follows:

Transparency No. 1

1. Scientific names are used world-wide. In the early 1900's botanists from most nations in the world met in Vienna and developed an International Code of Botanical Nomenclature. Even though it has been revised several times, it is still in world-wide use today. The botanical name of a plant in the United States will have the same name in any other country.

2. Using botanical names, greenhouse and nursery operators can purchase plants with accuracy. It is not unusual for an ornamental and nursery plant to have several common names. The common name is often given a plant in an area because of its growth characteristics. The growth habits of a plant may differ if it is grown under different environmental conditions. Therefore, ordering a plant by its common name is not a reliable method of ordering.

3. The scientific naming of plants permits the classifying and naming by taxonomists, people who are specialists in the field.

4. The scientific names for plants standardize all the terminology used by those handling plants.

5. A knowledge of the scientific name helps to identify the plant.

Newly discovered plants are often named by the person discovering it. The scientific name normally describes some characteristic of the plant. However, this is not always true. Other ways in which plants are given names are given below.

Transparency No. 2

1. The name may indicate where the plant was found. Examples are americana (America), korena (Korea), orientalis (Orient), and virginicus (Virginia),
2. Names of people are given to some plants. Examples are baileyi, wilsoni, and fortunei.
3. Scientific plant names may refer to the season of the year in which plants bloom: autumnale (autumn), praecox (very early), and aestivalis (spring).
4. The plant flower may be described in the scientific name. Examples are floribundus (quantity), grandiflora (size), or multiflora (many flowers).

The pronunication of a scientific name is not as important as the spelling. The plant name must be correctly spelled in order to positively identify it.

Transparency No. 3

Scientific names of plants always have two words, and sometimes three words are used. The first two words are Latin or Latinized. Latinized means the words are given in a Latin form. The first word in a scientific name is always capitalized, while the second word is never capitalized. The second word is used in place of the name of a person or thing. The third word sometimes is used to indicate that there is a small difference in two plants. Varietal name is the term given for the third word in the scientific name. The third word is often the name of the person who first named or described the plant.

Spinach is used as an example in the scientific name of a plant. Its scientific name is Spinacia oleracea Linne. The first word is called the genus or generic name. Genus means a class, kind, or group of plants with similar characteristics. Oleraceous in Latin means edible. The varietal name in the example is the name of the man who first discovered spinach.

As oleraceous is used as a descriptive term in the scientific name of spinach, other descriptive terms are often used in the scientific names of plants. There are many more descriptive terms than those shown in the following examples.

The terms below describe the foliage and forms of plant leaves:

augustifolius: narrow leaves
buxifolius: boxwood-like leaves
parvifolius: small leaves
populifolia: poplar-like leaves

The following words are used to indicate color of flowers and foliage:

albus: white
citrinus: yellow
purpureus: purple
rubens, ruber: red

Terms below refer to the native habitat of plants. The suffix ENSIS (of a place) is added to geographic names to specify the native habitat of the place where the first plant was discovered.

canadensis: Canada
chilensis: Chile
montanus: mountains
riparius: riverbanks

Terms given below are used to describe plant peculiarities which distinguish them from other plants:

armatus: armed
baccatus: berried
edulis: edible
floridus: tree flowering

3. The Plant Kingdom

There are many thousands of plants in the plant kingdom. They vary in size, structure, form, habits, reproduction processes, and usefulness to man. The variation in plant size is interesting when one thinks of the difference in size between a one-cell bacteria (classified as a plant) and the giant redwood trees found in California. Another interesting fact is that algae and fungi are members of the plant kingdom, even though they do not have stems or leaves.

The plant kingdom is divided into seven divisions or phyla. Two of the most important to those employed in a horticultural occupation are discussed.

1. Pteridophytes - Plants in this division have stems, leaves, and roots. Plants have been described as being an ancient group of fossil plants. Ferns, horsetails, and club mosses are included in this phyla.
2. Spermatophytes - This division is particularly important to the greenhouse and nursery worker because the plants produce flowers and are seed-bearing.

Each of the divisions are subdivided into subdivisions, called subphyla, below it. Gymnosperms and Angiosperms are subphyla of the Spermatophytes. Gymnosperms produce open seeds. About 700 species are in this subphyla. Cedars, pines, and firs are some plants in this category. There are about 250,000 species of Angiosperms. Included are the cultivated plants which produce seed in enclosed ovary walls. Corn, wheat, and barley are plants in this group.

Angiosperms are divided into two classes of plants, monocotyledonous and dicotyledonous. These are referred to as monocots and dicots. Monocots are plants that have one-seed leaves (cotyledons). About 50,000 plants, such as grasses, lilies, and palms, make up this group. Dicots produce two seed leaves, and herbs, shrubs, and trees are examples of plants found in this group. There are about 200,000 plants that are classified as dicots.

4. Other Means of Classifying Plants

Other ways in which plants may be classified are listed below.

Transparency Nos. 4A and 4B

Life Cycle Classification

Plants classified as to life cycle are called annuals, biannuals, and perennials. An annual plant completes its life cycle in one year. During this period, the plant blooms, produces seed, and dies. It is said that an annual is a plant that goes "from seed to seed" in one year or one growing season. Snapdragons, sweet pea, marigold, and verbena are annuals. A biannual (bi means two) requires two years or a part of two years to complete its life cycle. It goes "from seed to seed" in two years. Cabbage, beets, and carrots are examples. Perennials are plants that usually live more than two years. There are two kinds of perennials, woody, and herbaceous. The stems of a woody plant live over winter and are fairly hard or woody. Herbaceous generally grow and live for one season and have a soft, non-woody stem. Some perennials produce stems and leaves the first year and fruit the second year.

Growth Habit Classification

Using growth habit as a basis for classification, plants may be grouped as trees, shrubs, and vines. A tree is a plant that reaches a minimum of 12 feet in height, three inches in diameter, and has an erect stem. A shrub has several stems coming from the ground and does not get over 20 feet high. A vine is a plant that produces stems that are not strong enough to support it in an erect position.

Size Classification

Plants classified as to size may be placed in one of six categories.

1. Climbing Vine - A plant that will climb and grow on some type of support, such as a trellis, fence, or wall.
2. Ground Cover - Plants that attain the height of one foot or less, either trail or creep, and may form a compact mat. Turf is a ground cover.
3. Dwarf Shrubs - Woody plants that grow from one to three feet tall.
4. Medium Shrubs - Plants that grow from six to nine feet tall.
5. Large Shrubs - Woody plants that grow from 10 to 25 feet tall. Small ornamental trees are included in this group.
6. Standard Trees - Woody plants that grow to a height of 30 feet or more.

Form Classification

The growth habits of plants affect their form or shape. Most plants have either upright (vertical), rounded (horizontal), or spreading growth habits. Different shaped plants are used in the landscape to produce "eye appeal" and beauty. Some plants can be made to produce the desired form by pruning.

Foliage Classification

There are three groups within this classification. They are (1) deciduous, (2) needle-leaf evergreens, and (3) broadleaf evergreens. Deciduous plants lose their leaves in the fall of the year, while evergreens retain their leaves throughout the year.

Reference:

"Landscape Plant Identification," Vocational Instructional Services, Texas A&M University, College Station, Texas 1975.

ADVANTAGES OF USING SCIENTIFIC NAMES

* SCIENTIFIC NAMES ARE USED WORLD-WIDE
* TAXONOMISTS NAME & CLASSIFY PLANTS
* PLANTS PURCHASED WITH ACCURACY
* HELPFUL IN IDENTIFYING PLANTS
* STANDARD TERMINOLOGY

NAMING OF PLANTS

AN INDICATION OF WHERE PLANT WAS FOUND

americana (AMERICA)
korena (KOREA)
orientalis (ORIENT)
virginicus (VIRGINIA)

NAME OF PEOPLE

baileyi
wilsoni
fortunei

NAME MAY REFER TO SEASON

autumnale (AUTUMN)
praecox (VERY EARLY)
aestivalis (SPRING)

DESCRIPTION OF PLANT'S FLOWER

floribundus (QUALITY)
grandiflora (SIZE)
multiflora (MANY FLOWERS)

BOTANICAL NAMES OF PLANTS

SPINACH

SPINACIA OLERACEA LINNE

A. GENUS ——— SPINACIA

B. SPECIES ——— OLERACEA

C. VARIETAL NAME ——— LINNE

CLASSIFICATION OF PLANTS

Life Cycle Classification

annual

biennial

perennial (herbaceous / woody)

Growth Habit Classification

tree *shrub* *vine*

Size Classification

climbing vines

ground cover

dwarf shrubs

small shrubs

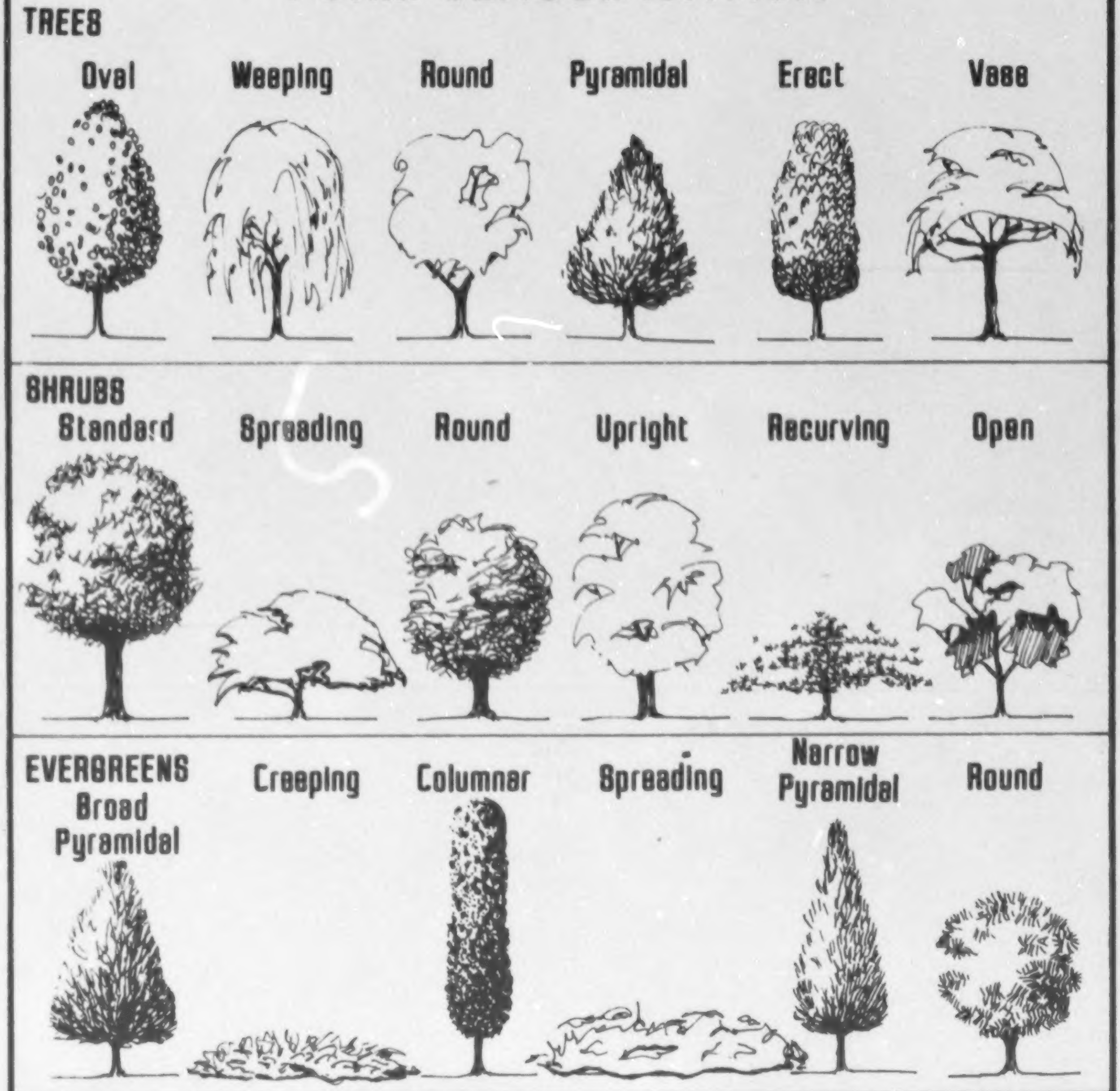
medium shrubs

large shrubs or ornamental trees

standard trees

CLASSIFICATION OF PLANTS

FORM CLASSIFICATION


TREES
Oval
Weeping
Round
Pyramidal
Erect
Vase
SHRUBS
Standard
Spreading
Round
Upright
Recurving
Open
EVERGREENS
Broad Pyramidal
Creeping
Columnar
Spreading
Narrow Pyramidal
Round

FOLIAGE CLASSIFICATION

DECIDUOUS
NEEDLE-LEAF EVERGREENS
BROADLEAF EVERGREENS

CVAE AND VEH HORTICULTURE

Unit B: Plant Classification and Identification

Topic 2: Identifying Plants by Leaf, Flower, and Bud and Stem Characteristics

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

The laboratory exercise at the end of this topic should be helpful to the students in identifying plants.

1. Identifying Plants by Their Leaves

Botanists may use a botanical key to identify plants, but most people do not have the knowledge to use a key. It is necessary for these people to rely on their memory of plant characteristics. There are a number of factors to consider when observing a plant for identification purposes. The order in which the characteristics is discussed in this topic appears to be a logical sequence for observing plants.

Leaf Structure (Morphology)

Transparency No. 1

The two major areas of the leaf to observe are the blade and the blade stalk. Veins and soft tissue may be seen in the leaf blade. Leaf veins will indicate whether the plant is a dicot or monocot. In dicots the veins branch several times and are referred to as being netted. The leaf veins in a monocot are usually parallel. The parallel veins are about the equal in size and are parallel from the base to near the tip. There are many variations in vein arrangement of leaves. Not all leaves have a blade stalk. The blade is attached directly to the stem.

Stem Arrangement

Transparency No. 2

The next observation to be made is the stem arrangement. The most common leaf positions on plant stems are of three types: (1) whorled, (2) alternate, and (3) opposite. A whorled leaf pattern has three or more leaves at the nodes of the plant. This is a common stem arrangment in herbaceous (succulent) plants. Leaves arranged on the stem in an alternating pattern are referred to as being alternate. Two leaves on opposite sides of the node have an opposite stem arrangement. The leaves on some plants are opposite, but each pair is at a right angle to the one above it. The term used to describe this arrangement is "decussate."

Venation Patterns

Transparency No. 3

Leaves of different plants have different venation patterns. Terms used to describe the veins in the leaves are parallel, pinnate, and palmate. Leaves with the pinnate venation pattern have one major vein with secondary veins branching from the midrib. A palmate pattern has three or more major veins extending from the base of the blade and secondary veins branching from the main veins. Parallel leave veins are about equal in size and are parallel from the base to near the tip.

Leaf Forms

Transparency No. 4

Simple - A blade in one segment, or it has one blade.
Compound - A leaf with the blade divided into several sections and attached to a common stalk. They resemble the fingers on the hand.
Pinnately Divided - A compound leaf with leaflets arranged along both sides of the stem bearing the leaflets.
Palmately Divided - All leaflets come from a point at the tip of the bladestalk.

Shape of Leaves

Transparency No. 5

The more common leaf shapes are shown in the above transparency.

Leaf Apex

Transparency No. 6

Leaf Bases

Transparency No. 7

Leaf Margins

Transparency No. 8

Leaf Surfaces

Transparency No. 9

2. Plant Flowers

Transparency No. 10

The flowers produced by different plants vary greatly in size, structure, and composition. Plants produce two kinds of flowers, complete and incomplete. Complete flowers have four parts: sepals, petals, stamens, and pistils (carpels). Each part of the complete flower has a function. The sepals prevent the rapid evaporation of moisture in the inner part of the flower. The petals serve as protection for the flower. The stamen is the male part of the flower. Pollen is produced in this area. The pistil contains the ovary, which is the female part of the flower.

Many flowers are incomplete and may not contain the petal or sepal, and some flowers do not contain a stamen.

3. Characteristics of Buds and Stems

Horticultural plants possess many bud and stem characteristics which are helpful in identifying them. Positions of leaves, buds, twig surfaces, and pith are areas to observe.

Position of Leaves

Leaves are positioned on plant stems in such a way as to encourage photosynthesis. Because of the differences in leaf positions on different plants, the appearance of the stem is useful in identifying plants.

Buds

There are two normal positions of buds on woody plants. However, all buds are not found in a normal position. Often buds develop in an abnormal position if the plant is wounded. These are called adventitious buds.

Transparency No. 11

One normal position for a bud is between the leaf and stem (leaf axis). The other normal position for buds to develop is at the tip of a twig or branch. Buds located in the leaf axis are called axillary buds. Those growing at the tip of a stem are called terminal buds.

Other terms used to describe buds are listed below:

1. Pseudoterminal Bud - An axillary bud that functions as a terminal bud.
2. Lateral Bud - An axillary bud found in the leaf axil.
3. Collateral Bud - Buds found on either side of a lateral or axillary bud.
4. Superposed Bud - The bud above an axillary bud.

Twig Surface

The color, covering of fine hairs (pubescence), presence or absence of corky ridges, thorns, spines, and prickles are useful in the identification of plants.

Transparency No. 12

The first three areas mentioned can be readily observed. An explanation is given for the latter three. Short-pointed woody branches (thorns) are found on many of the native plants in Texas. The pyracantha plant is an example.

Prickles develop on the surfaces of some plants, These are not connected to the vascular tissue, and may be dislodged by pushing them sidewise. The rose is an example of a plant that has prickles.

Spines are easily distinguished from thorns because the leaf forming the spine is always below a branch or bud. Spines may form on the top of a leaf, on leaf margins, and in other areas.

Pith

The center portion of a stem is called the pith. Shape, color, and type of pith may be used to identify plants. Three types of pith are shown in the above transparency. Spongy (irregular small cavities) and hollow (lacking cellular pith) are not shown.

Laboratory Exercise

Activity:
Collect leaves of plants, make leaf imprints on 4" x 6" cards, and complete an information sheet on each plant. The purpose of the exercise is to teach students plant identification.

Materials:

1. Leaves of several kinds of ornamental horticultural or greenhouse plants
2. 4" x 6" cards, unruled
3. Rubber stamp ink pads (approximately 3-1/2" x 6")
4. Information sheets (8-1/2" x 11")

Procedure:

1. After students have covered information in topic and have had the opportunity to examine live plants and familiarize themselves with the identifying characteristics, they should be given an assignment to bring to class the leaves of several horticultural plants; or the teacher may wish to have a class field trip and have the students collect the leaves while on the field trip. Each student should be required to secure only enough leaves to give him sufficient practice in making the imprints and completing the information sheet.

2. Select leaf speciments that will fit within the limits of the 4" x 6" card. If the leaves from a specimen are small, the student may wish to make the

imprint of several leaves on one card. The entire leaf should be included in the imprint. If the compound leaf is too large, a single leaflet may be used, but a sketch of the entire leaf should be drawn on the card.

3. Making Imprints - The bottom surface of the leaf makes the best imprint. The imprint is made by placing the leaf on an inked pad and covering the leaf with a card or piece of paper. Pressure is applied to the card with the fingers until the leaf is uniformly coated with ink. The inked leaf is placed on a 4" x 6" card and covered with another clean card, and the surface of the card is rubbed uniformly to transfer the image.

4. The name of the plant should be written on the card.

5. The information sheet should be completed. This sheet should include the following information: scientific name (genus and species), common name, height, spread, shape, growth conditions (shade, part shade, full sun, etc.), uses (foliage, flower, fruit, bark, etc.), identifying characteristics (foliage, flower, leaves, stem arrangement, venation pattern, leaf shapes, etc.), leaf position, buds, stems, and other identifying characteristics. The following information sheet may be used to record information.

Plant Information Sheet

1. Name: ____________________ ____________________
scientific common

2. Plant Shape: ______________ ______________ ______________
upright rounded spreading

3. Growth Habit Classification: __________ __________ __________
tree shrub vine

4. Foliage Classification: ____________ ____________ ____________
Deciduous Needle-leaf Evergreen Broadleaf Evergreen

5. Leaf Characteristics:
   a. Stem arrangement ____________ b. Venation pattern ____________
   c. Leaf form ________ d. Leaf margin ________ e. Leaf shape ________

6. Bud Position:
   a. Leaf axis __________ b. Tip __________ c. Other __________

7. Twig Surface:
   a. Color _________ b. Hairs _________ c. Corky ridges _________
   d. Thorns _________ e. Spines _________ f. Prickles _________

8. Pith:
   a. Shape ______________ b. Color ______________ c. Type ______________

9. General Remarks:

____

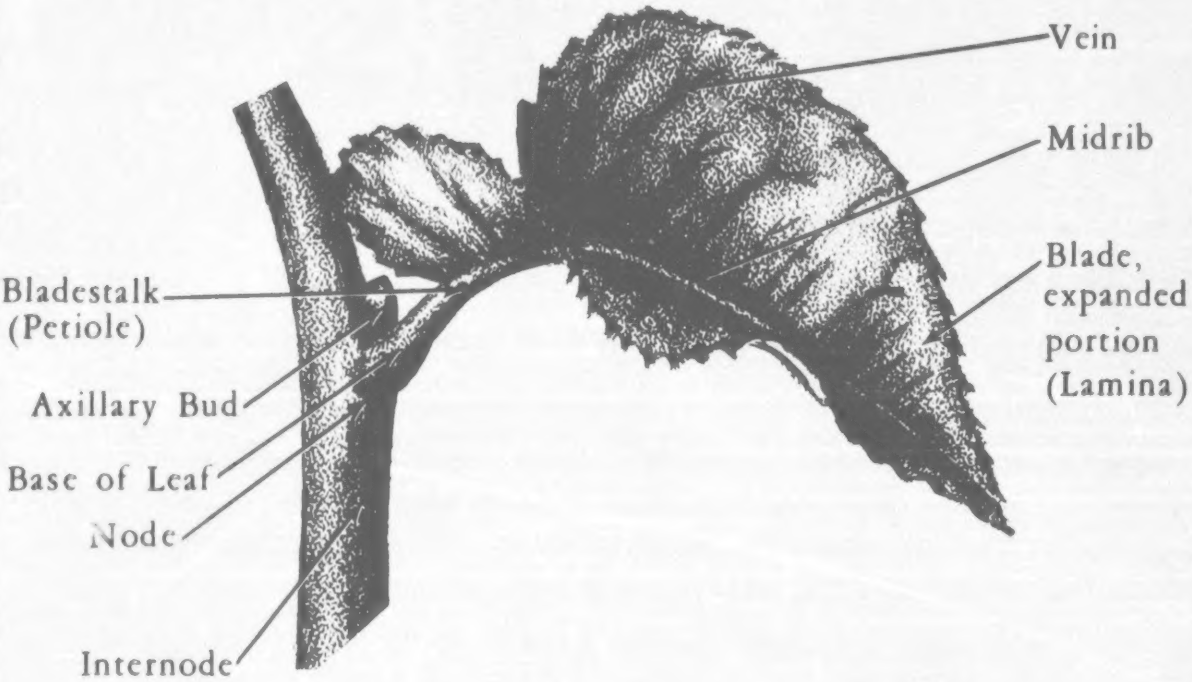
____

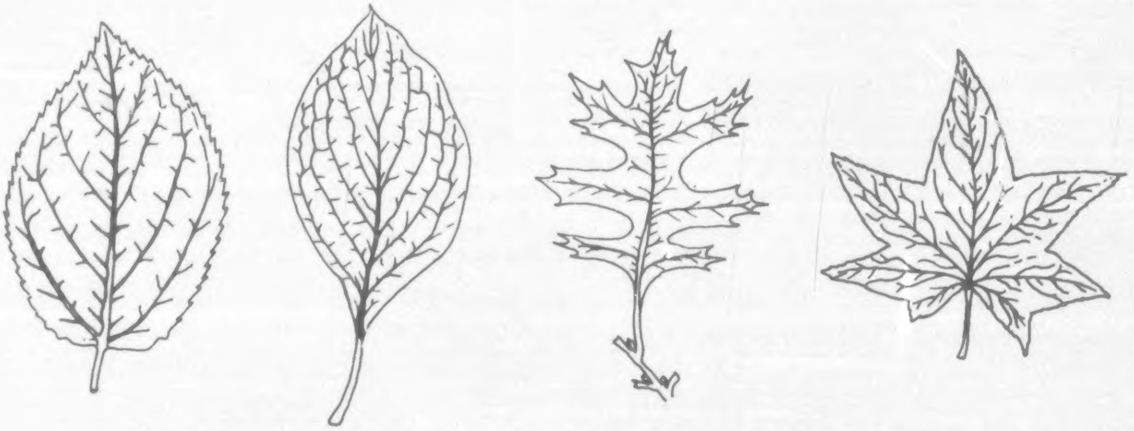
____

References:

1. "Landscape Plant Identification, "Vocational Instructional Services, Texas A&M University, College Station, Texas, 1975.
2. Benson, Lyman, Plant Classification, D.C. Heath and Company, Boston, MA, 1957.
3. Janick, Jules, Horticultural Science, W.H. Freeman and Company, San Francisco, CA, 1963.

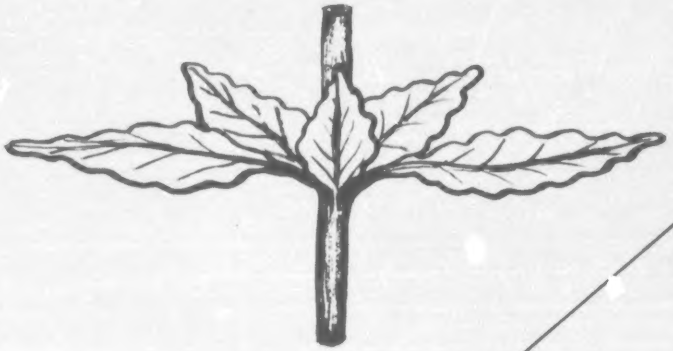
LEAF STRUCTURE (MORPHOLOGY)


Vein
Midrib
Blade, expanded portion (Lamina)
Bladestalk (Petiole)
Axillary Bud
Base of Leaf
Node
Internode

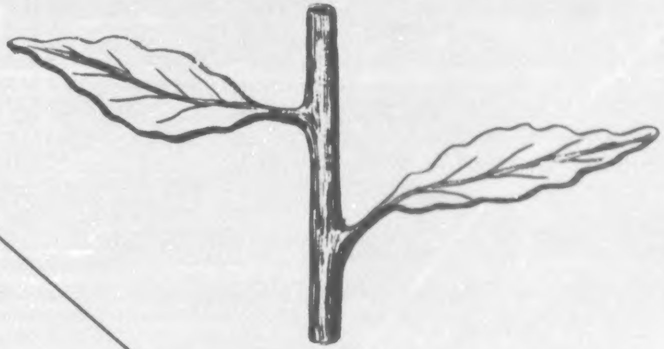


DICOT LEAVES WITH NETTED VEINS

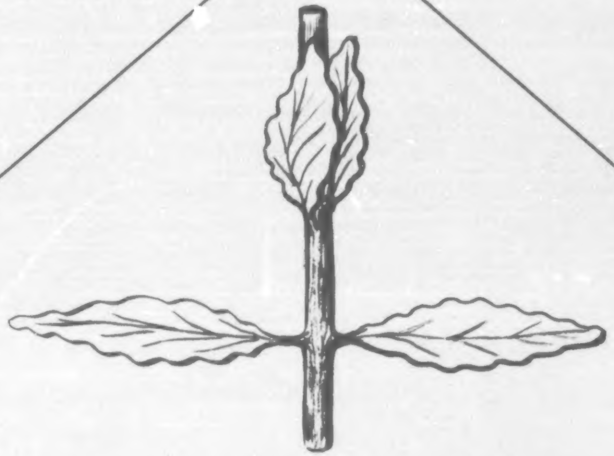
STEM ARRANGEMENT



WHORLED

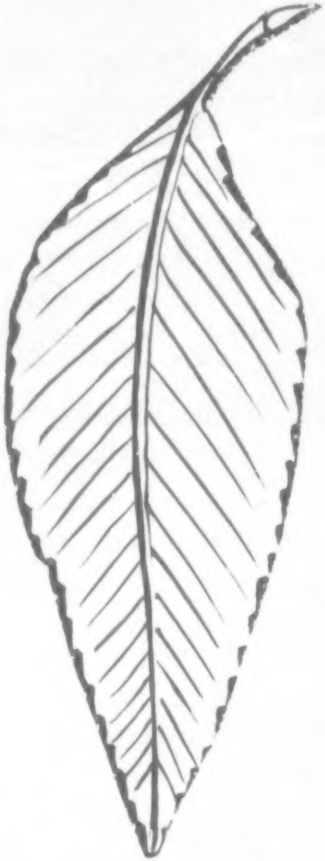


ALTERNATE

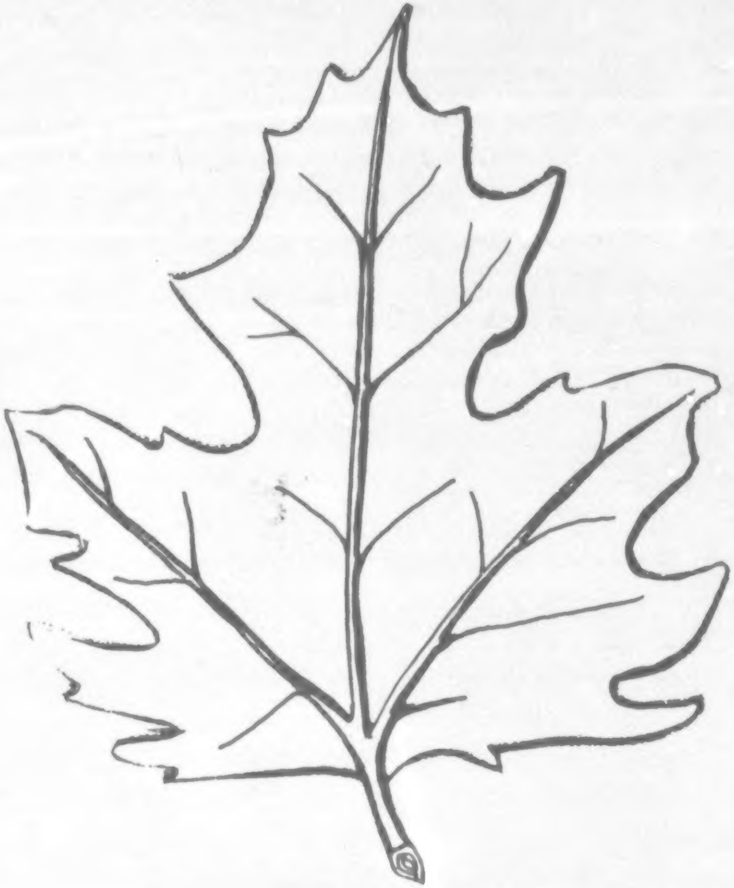


OPPOSITE

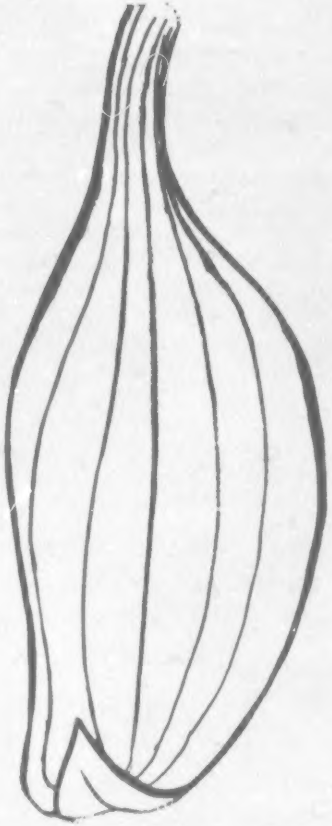
VENATION PATTERNS



Pinnate

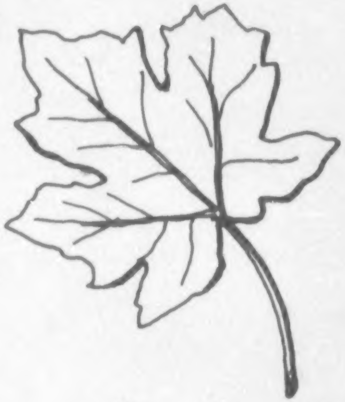


Palmate

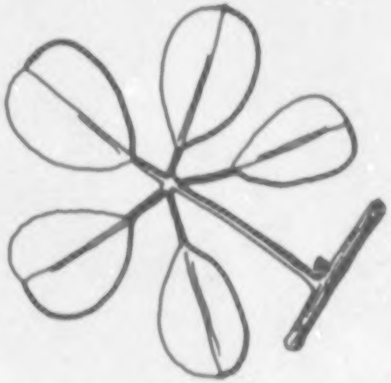


Parallel Veins

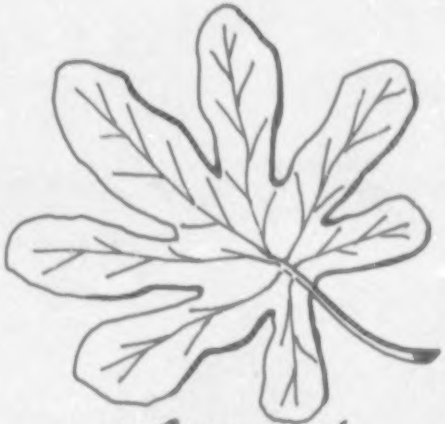
LEAF FORMS



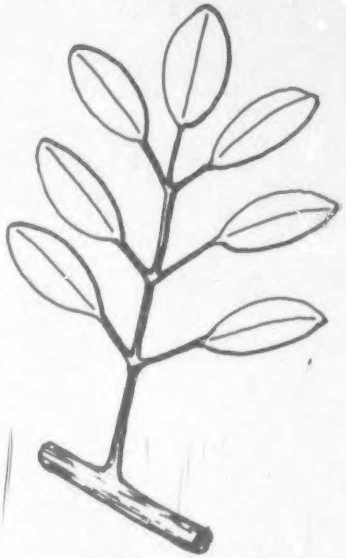
Simple



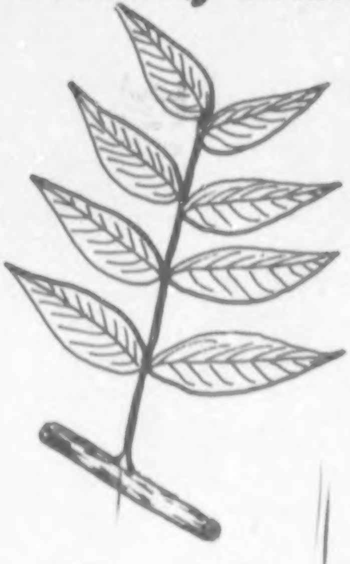
Palmately divided



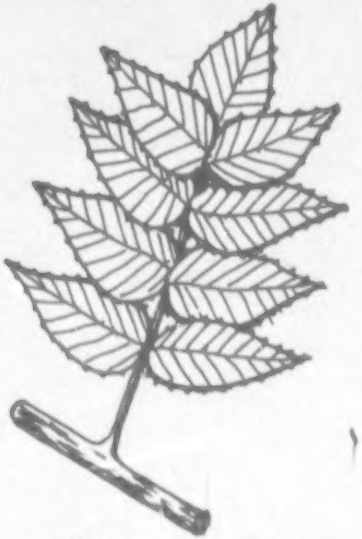
Compound



Pinnately divided

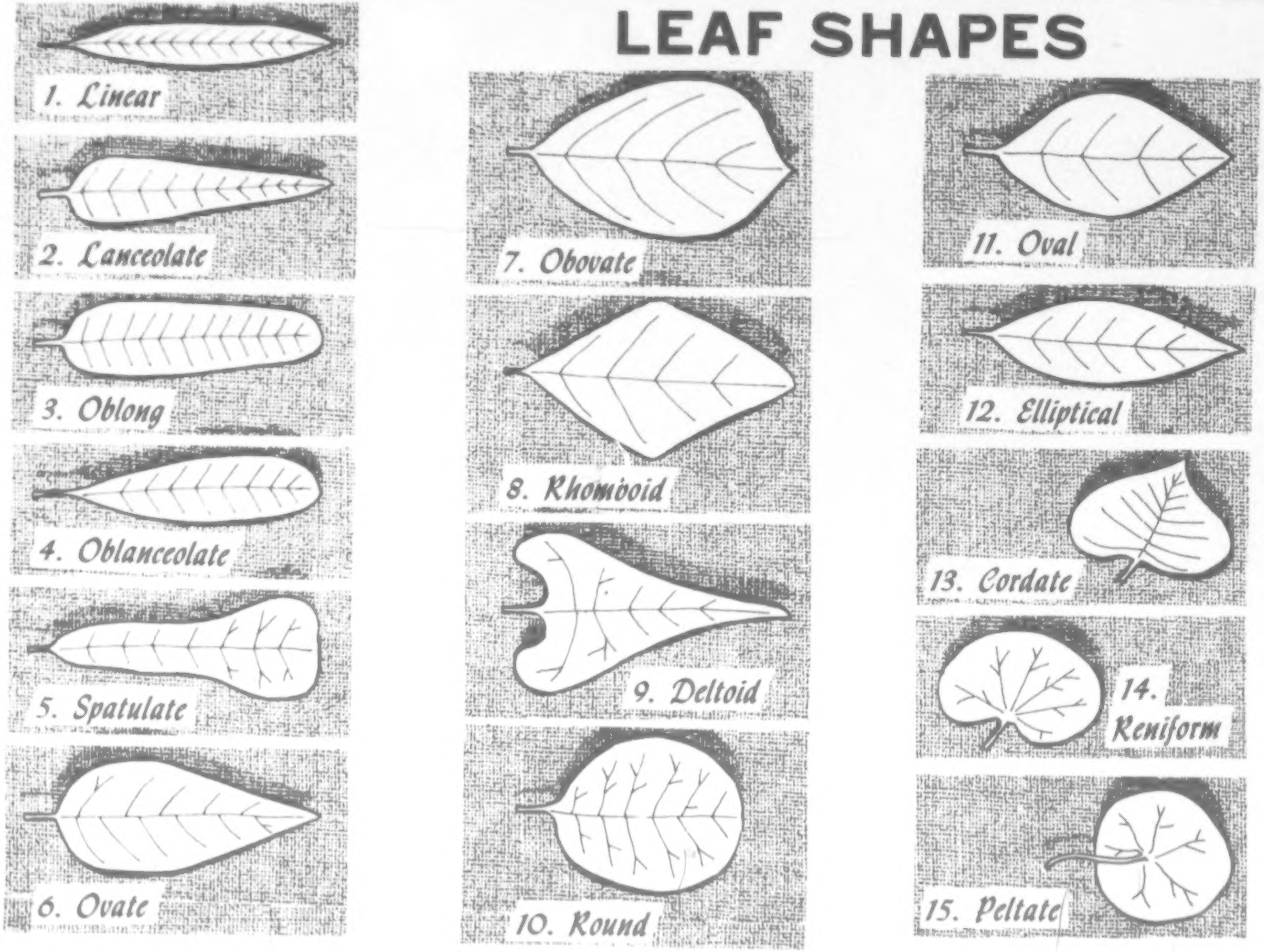


Even-pinnate

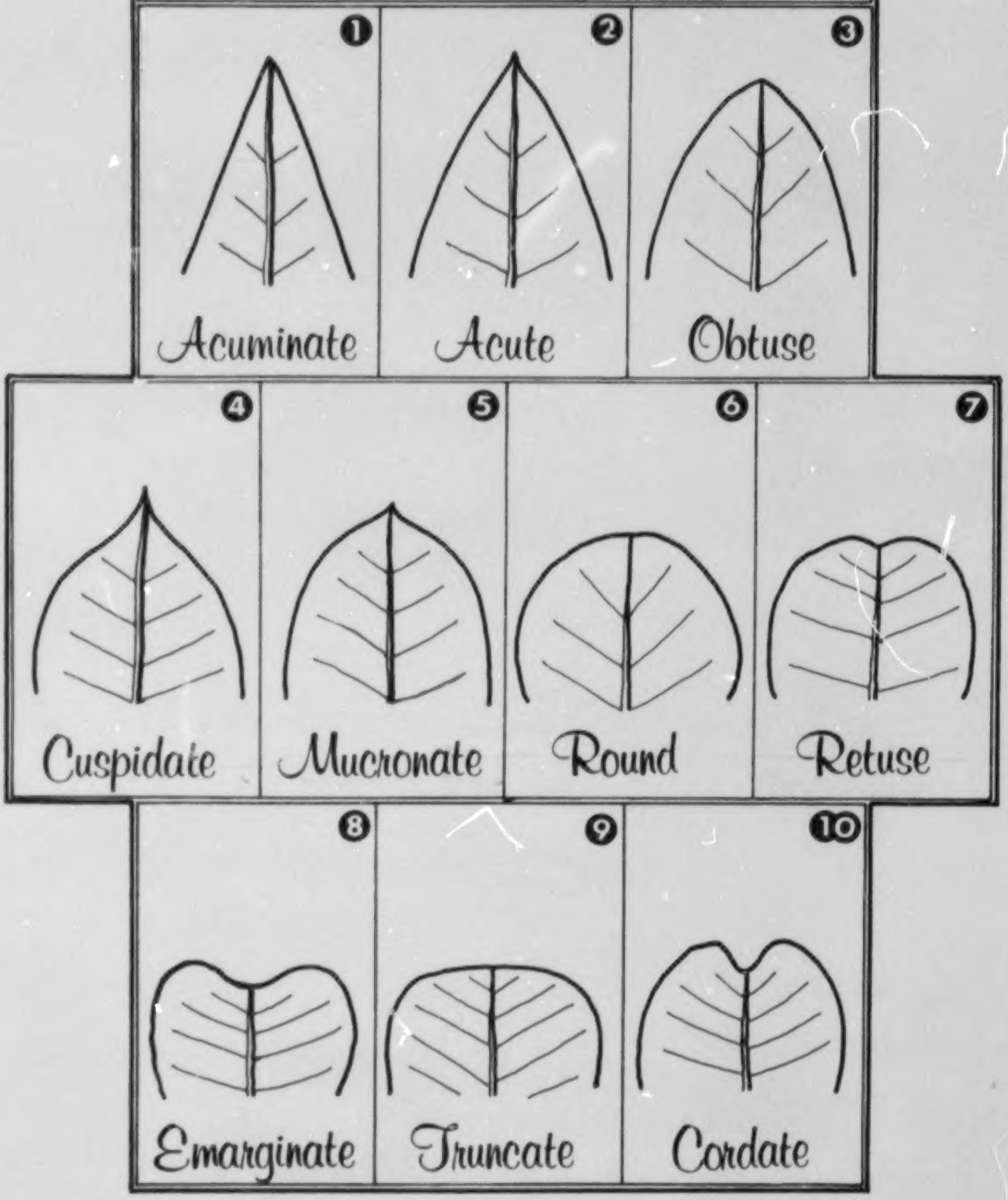


Odd-pinnate

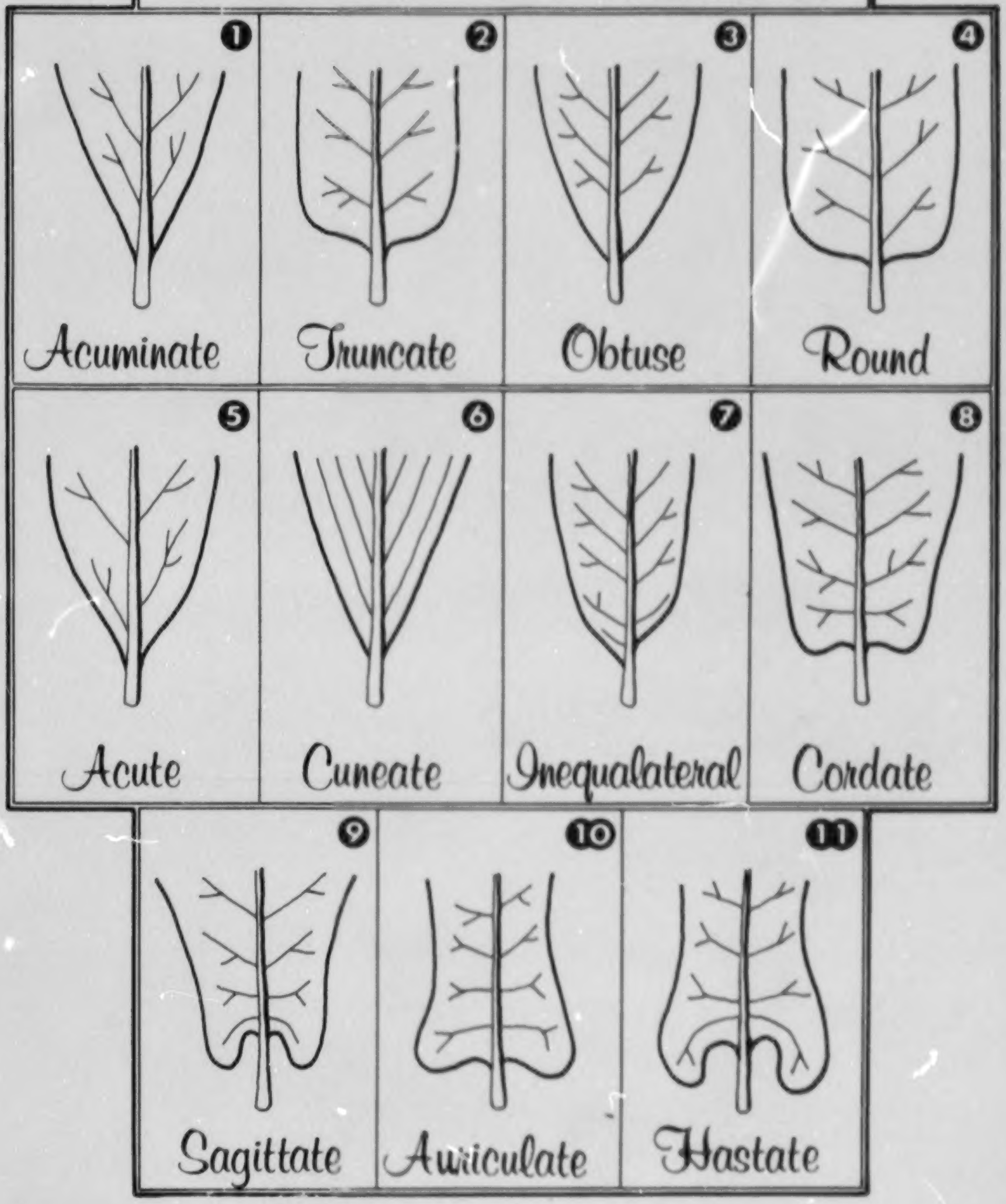
LEAF SHAPES


1. Linear
2. Lanceolate
3. Oblong
4. Oblanceolate
5. Spatulate
6. Ovate
7. Obovate
8. Rhomboid
9. Deltoid
10. Round
11. Oval
12. Elliptical
13. Cordate
14. Reniform
15. Peltate

LEAF·APEXES


1
Acuminate
2
Acute
3
Obtuse
4
Cuspidate
5
Mucronate
6
Round
7
Retuse
8
Emarginate
9
Truncate
10
Cordate

LEAF·BASES


1
Acuminate
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Truncate
3
Obtuse
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Round
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8
Cordate
9
Sagittate
10
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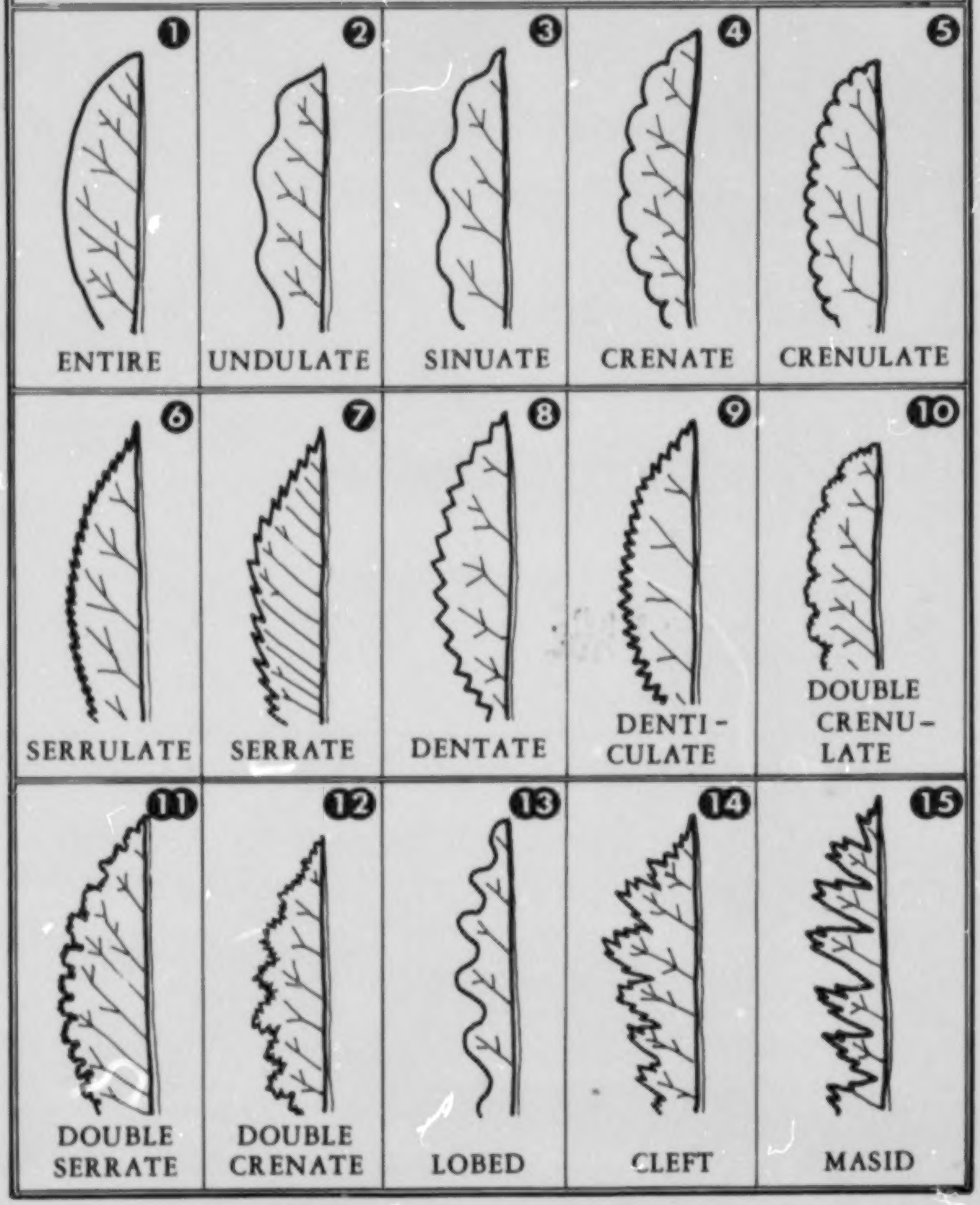
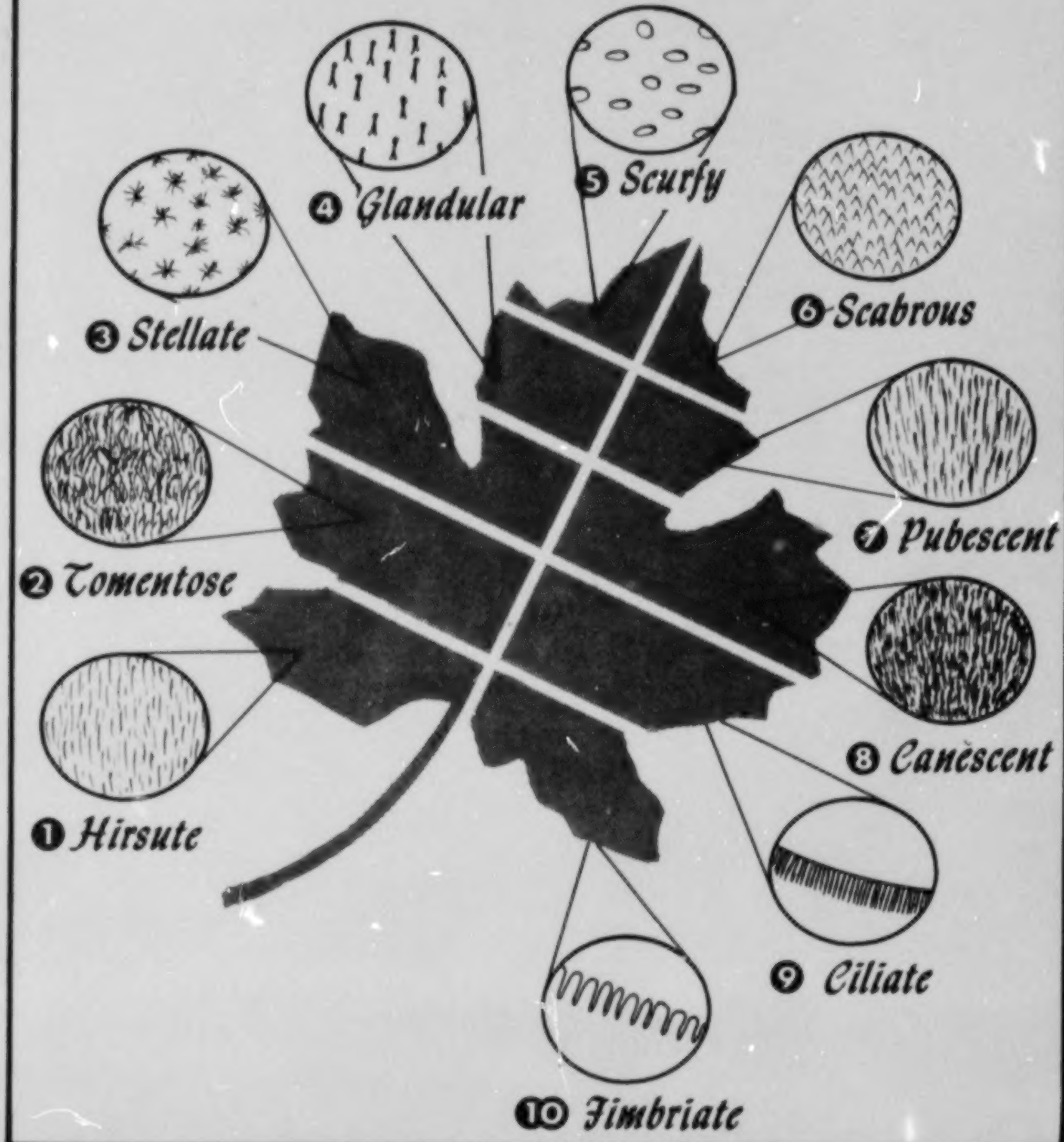
11
Hastate

LEAF MARGINS

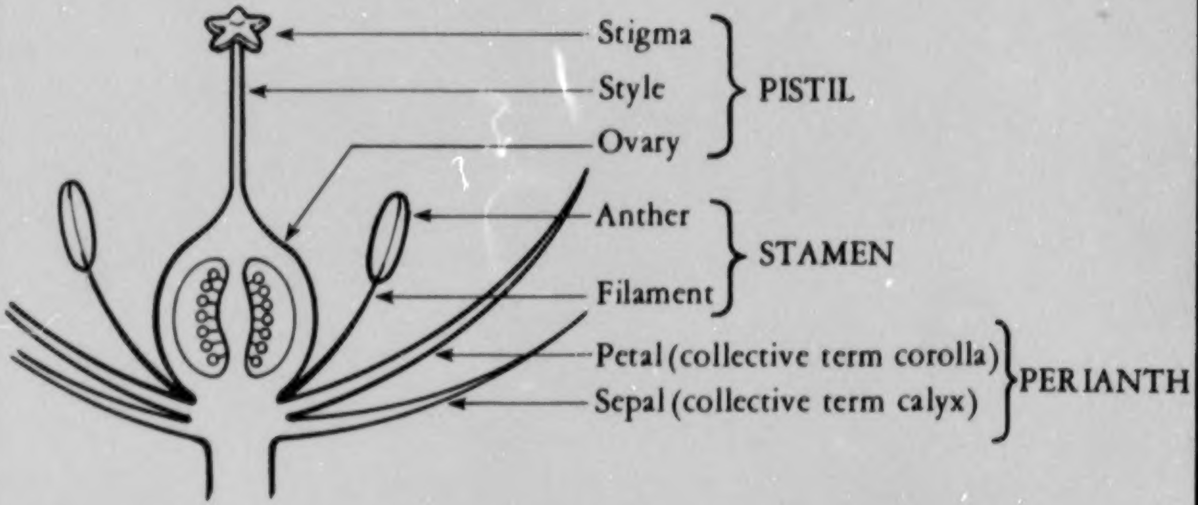


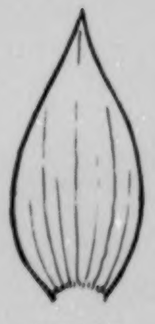
1 ENTIRE
2 UNDULATE
3 SINUATE
4 CRENATE
5 CRENULATE
6 SERRULATE
7 SERRATE
8 DENTATE
9 DENTICULATE
10 DOUBLE CRENULATE
11 DOUBLE SERRATE
12 DOUBLE CRENATE
13 LOBED
14 CLEFT
15 MASID

LEAF SURFACES

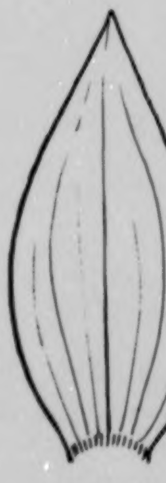

❶ Hirsute
❷ Tomentose
❸ Stellate
❹ Glandular
❺ Scurfy
❻ Scabrous
❼ Pubescent
❽ Canescent
❾ Ciliate
❿ Fimbriate

PARTS of a FLOWER

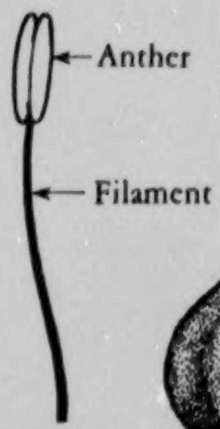

Stigma
Style
Ovary
PISTIL
Anther
Filament
STAMEN
Petal (collective term corolla)
Sepal (collective term calyx)
PERIANTH



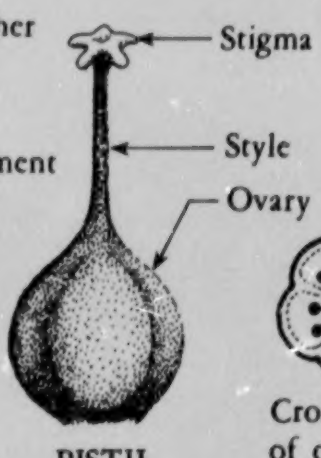
SEPAL



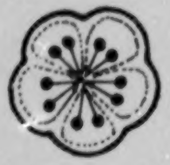
PETAL


Anther
Filament

STAMEN

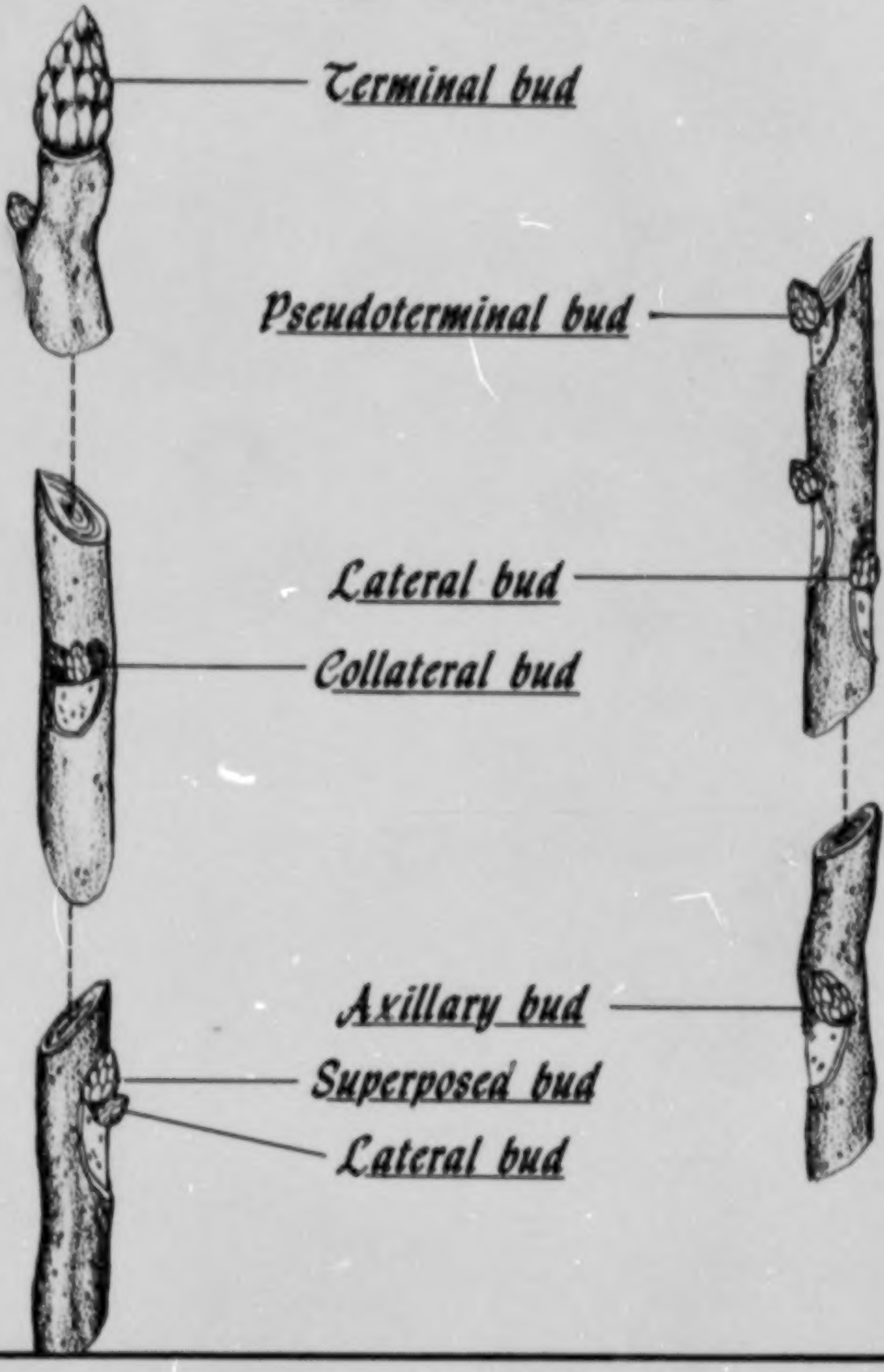

Stigma
Style
Ovary

PISTIL

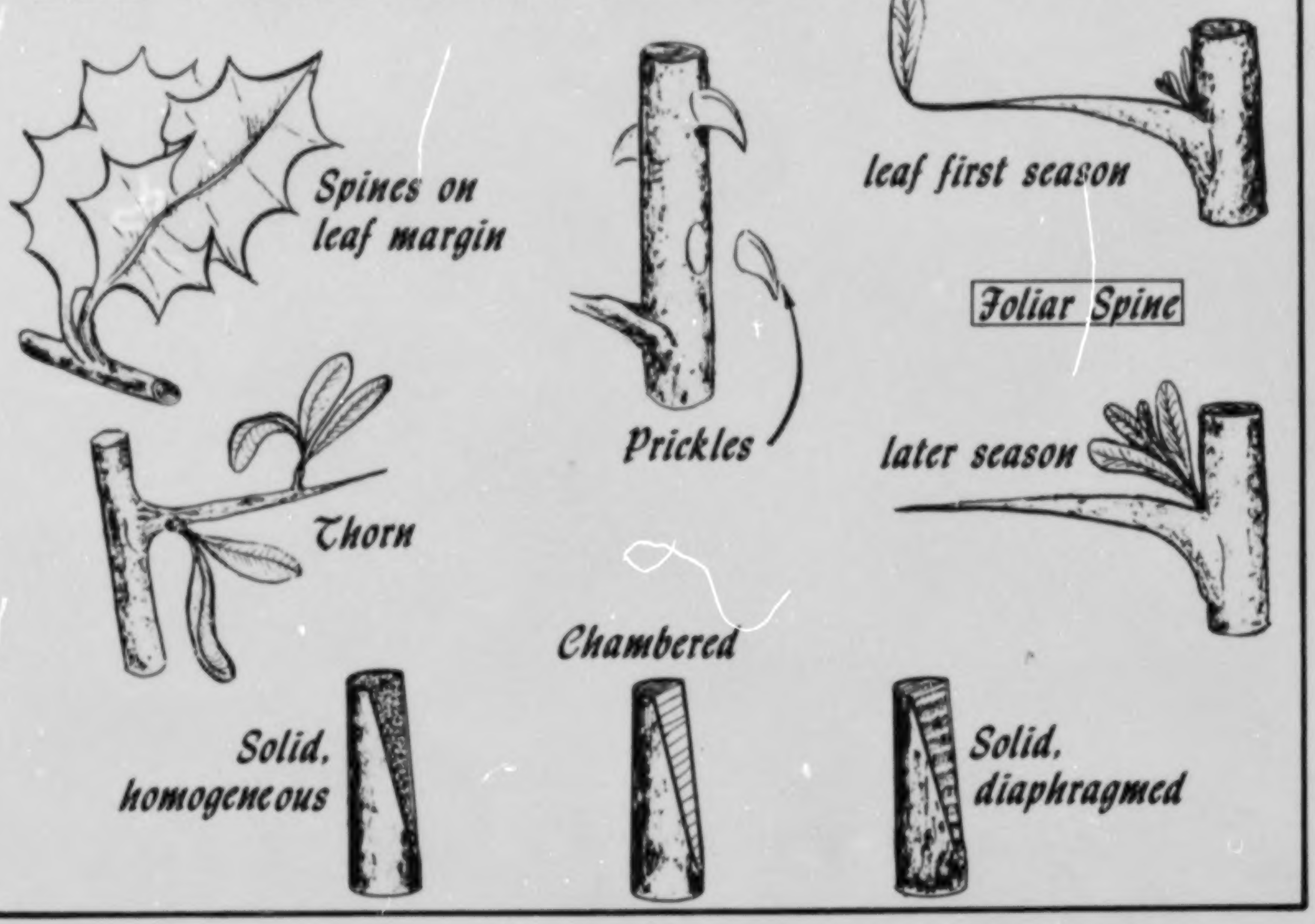


Cross section of ovary with five carpels

TYPES OF BUDS


Terminal bud
Pseudoterminal bud
Lateral bud
Collateral bud
Axillary bud
Superposed bud
Lateral bud

BUD & STEM MORPHOLOGY



Spines on leaf margin

Prickles

Thorn

leaf first season

Foliar Spine

later season

Chambered

Solid, homogeneous

Solid, diaphragmed

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CVAE AND VEH HORTICULTURE

Unit C: Structures and Equipment used in Producing Greenhouse, Ornamental, and Nursery Plants

Topic 1: Structures Used in Producing Plants

Note: All terms underlined are included in the "Glossary of Terms."

1. Greenhouses, Coldframes, and Hotbeds

Structures used to grow plants in a season in which they are not normally grown are called forcing structures. Greenhouses, coldframes, and hotbeds are used as forcing structures, but they also have other uses.

Greenhouses

Greenhouses make it possible to grow plants the year around because the environment and other requirements can be supplied artificially. In addition to growing plants, the greenhouse is the most efficient structure for propagating plants.

The growing of plants in greenhouses with a nutrient solution instead of a growing media is referred to as hydroponic growth of plants. Sand or fine gravel is normally used to hold the plants upright.

Transparency No. 1

There are a number of different styles of greenhouses. Five different styles are discussed.
Even Span - Most commercial greenhouses are of this type and have gable roofs. The distance of the roof to the eave and ridge are identical on each side of the greenhouse. This type allows light exposure to all areas in the greenhouse.
Lean-To- This style is one-half of an even span house and is placed against the wall of another building. In order for a structure of this type to permit adequate light for the growing plants, it must be located against the south wall of the supporting building. Its length should run east and west. Being located in this manner, the greenhouse still will be shaded a part of the day.
Uneven or 3/4 Span - This is the least popular of all styles. It is usually constructed on a slope with the short side of the roof being on the upper side of the slope.
Quonset - This style has a semicircular arch that starts at ground level or just above ground level. The absence of posts and a pitched roof are the advantages of building a quonset greenhouse. It is available in various widths and lengths.
Ridge and Furrow - Several even span greenhouses are joined at the eaves when

building this type. It permits a large area to be covered with one roof. This is the most common style when constructing a greenhouse range. Since the roof sections are not easily accessible, more maintenance time is required for this style.

Transparency No. 2

Coldframes

These are used to harden or condition plants before planting them in a field or nursery. They may also be used to condition container plants. A coldframe and hotbed are similar in appearance. Artificial heat is not applied to a coldframe. The coldframe may be covered with windows or hotbed sashes, plastic, or cloth. If cloth is used, it is normally removed during the warmer part of the day. Sides of the coldframe may be constructed of wood or masonry materials.

Hotbeds

Hotbeds may be used for the same purposes as a greenhouse, but they are generally used by small scale operators to germinate seeds or start seedlings and leaf cuttings. Large operators may fill an entire greenhouse with beds and use them to germinate seeds.

Artificial heat is applied to the hotbed under the media by electric heating cable, hot water, steam pipes, or hot air flues. The most economical and efficient heating system for hotbeds in Texas is usually electricity. A lead or plastic-covered soil heating cable is used. A thermostat should be installed on the heating cable so as to provide an even heat. Placement for the heating cable in the hotbed is shown in the above transparency.

Two factors, (1) type of covering to be used and (2) number of plants to be produced, will determine the dimensions of the hotbed. When windows or hotbed sashes are used, the hotbed should be six feet wide. This will permit the use of a standard 3 foot by 6 foot sash. When a plastic film cover is used, any convenient size may be built. The hotbed frame, depending on its expected life, may be built of wood or masonry materials.

2. Other Plant Growing Structures

In addition to the structures previously mentioned, several other types are used to grow plants. The type selected will depend upon the length of time the structure will be used, plants to be grown, cost, and operating expense.

Lathhouse

This type of structure is used to protect container-grown and shade-loving plants from the sun, condition them, and hold them until they are sold.

Snow or picket fencing or wood strips placed over metal or wood frames make an ideal lathhouse. The frame should be seven to eight feet above ground level. Strips are two inches wide and placed to provide one-third to two-thirds shade.

Forcing Hills

These are used to protect field plants from cold and wind. They may be made of plastic, cardboard, or other materials and are placed over the plants. They should allow some sunlight to the plant. After the danger of extreme weather has passed, the protection is removed.

Transparency No. 3

Mist Beds

Mist beds are used primarily for the propagation and rooting of plants from leaf cuttings. They may be used inside a greenhouse, lathhouse, or out-of-doors.

When properly used, the mist bed prevents the cuttings from wilting before roots are formed. A watering system is installed over the bed that will intermittently spray a fine mist of water over the bed and cuttings. The mist increases humidity, lowers the temperature, and reduces transpiration and respiration.

Nozzles are connected to water pipes, and a fine mist covers the entire bed. The water pipes may be placed in the center of the bed or in the center of two beds. Placement of nozzles should be close enough to cover all of the bed. Electrical control devices are used to regulate the frequency of mist.

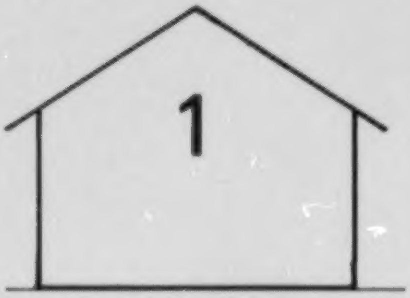
Fluorescent Light Boxes

These are used in the germination of some seeds. They assist the plants emerge from the soil and in the growth of vigorous plants. The light encourages photosynthesis, which produces carbohydrates and other materials needed by the plants for growth. A relatively high light intensity is used; however, too much light can damage the plants by producting excessive heat.

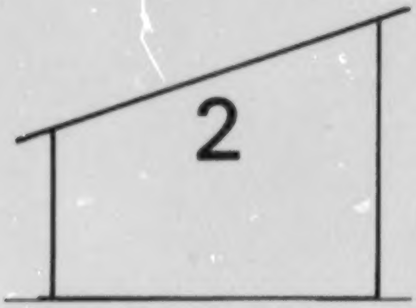
References:

1. Laurie, Alex and others, Commercial Flower Forcing, McGraw-Hill Book Company, New York 1969.
2. Hartmann, Hudson T. and Dale E. Kester, Plant Propagation, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968.

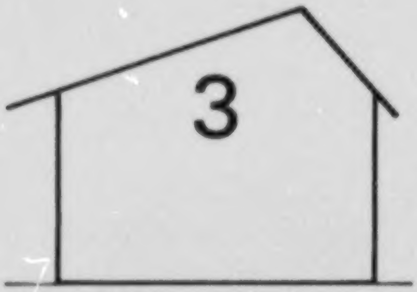
STYLES OF GREENHOUSES



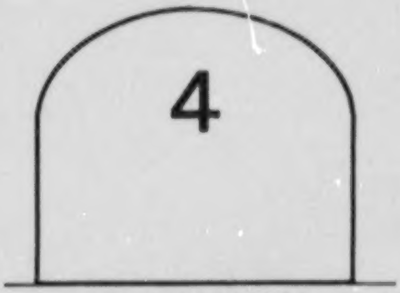
EVEN SPAN



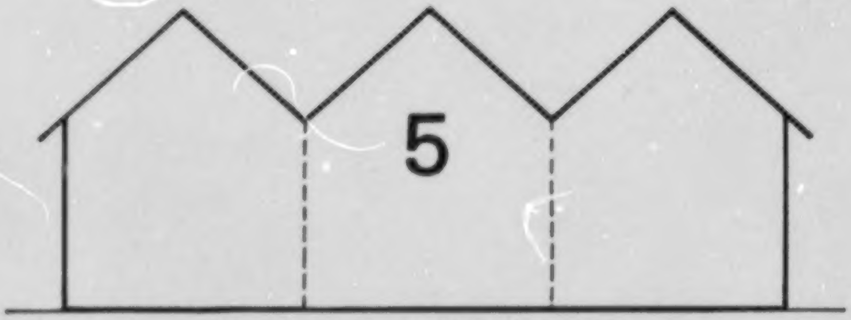
LEAN-TO



UNEVEN OR 3/4 SPAN

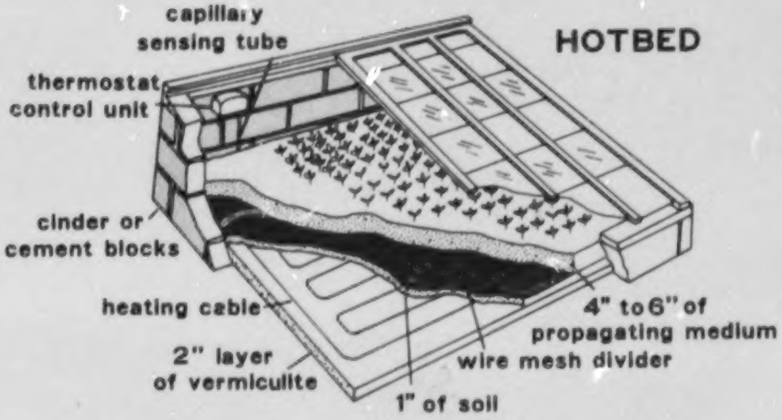


QUONSET

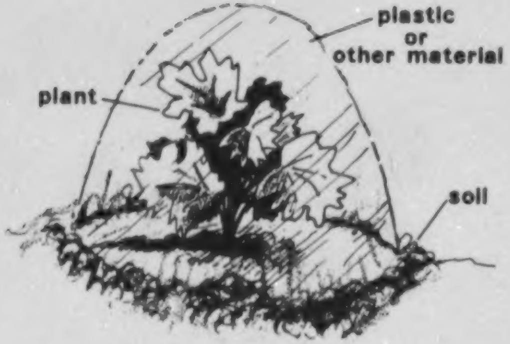


RIDGE & FURROW

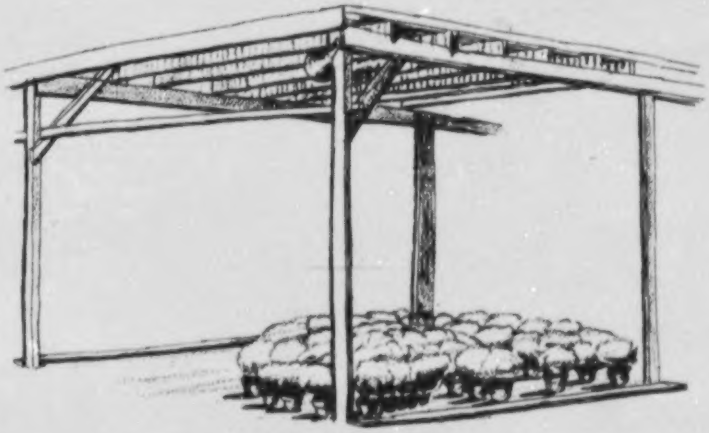
OTHER FORCING STRUCTURES


capillary sensing tube
thermostat control unit
cinder or cement blocks
heating cable
2" layer of vermiculite
1" of soil
wire mesh divider
4" to 6" of propagating medium

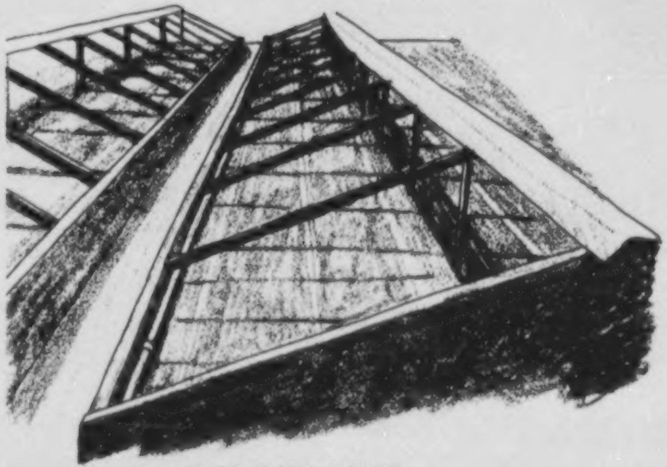
HOTBED


plastic or other material
plant
soil

FORCING HILLS

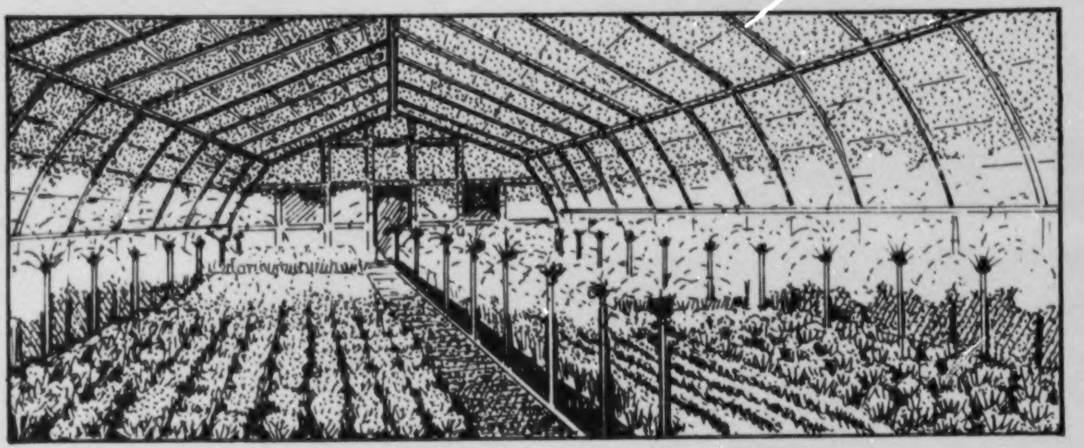


LATHHOUSE

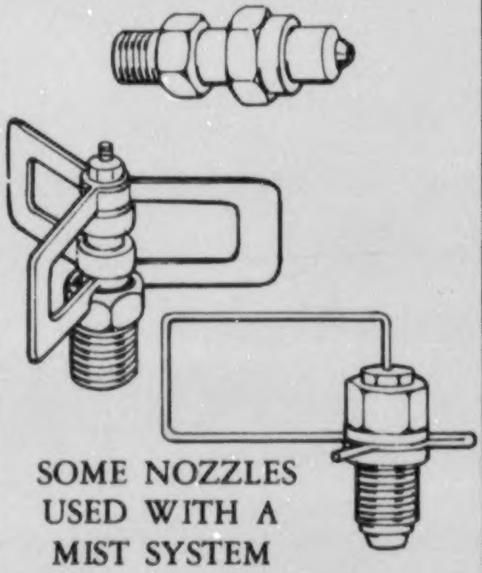


COLDFRAME

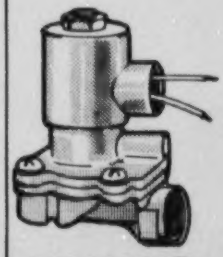
MIST SYSTEM EQUIPMENT



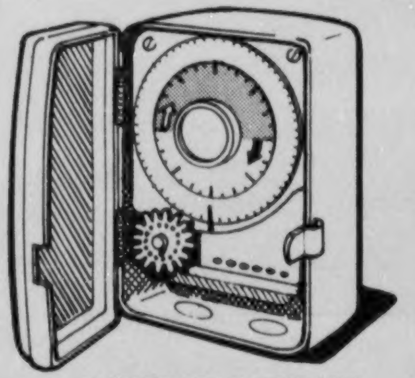
MIST SYSTEM IN A GREENHOUSE



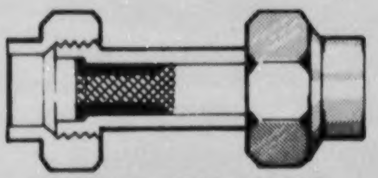
SOME NOZZLES USED WITH A MIST SYSTEM



SOLENOID (electric water valve)



INTERVAL TIMER



WATER STRAINER

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C-2
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit C: Structures and Equipment Used in Producing Greenhouse, Ornamental, and Nursery Plants

Topic 2: Greenhouse Parts and Coverings

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Samples of the different kinds of greenhouse coverings should be made available to students.

1. Greenhouse Parts

It is important that the manager or owner be familiar with the structural parts used in constructing a greenhouse. Periodic maintenance and repairs are essential to the efficient operation of a greenhouse and in order to obtain maximum plant growth.

Transparency No. 1

The greenhouse consists of the following parts:

1. Side posts (called gutter posts on a ridge and furrow house) - these posts are spaced at intervals of ten feet and support the trusses.
2. Trusses - The number of trusses used to construct a greenhouse is determined by its length; the truss supports the roof covering.
3. Rafter - (Trusses are constructed
4. Struts from rafters, struts,
5. Ties and ties.)
6. Eave or gutter - The eave extends from post to post at the point where the truss joins the side post.
7. Ridge and ridge cap - These extend from one truss to another and run the length of the greenhouse.
8. Purlin - The purlins serve as braces and extend from truss to truss.
9. Curtain wall - If maximum light is desired for plants growing under benches, the curtain wall should be omitted. The curtain wall is usually made of concrete or masonry blocks.
10. Sidewall - This is the area from the ground to the eave.
11. Ridge vent - This vent will not be found on all greenhouses; it is named after the area where it is located.
12. Side vent - This vent is located on the side of the greenhouse. Ridge and side vents are used for ventilation in case of power failure. They increase the cost of the greenhouse.
13. Sash bars - These are approximately twenty-four inches wide and run from the ridge to the eave.

14. Wall bars - These serve as a base for the greenhouse covering and extend from the eave to the sill.
15. Sill - It rests upon the curtain wall and serves as a base for the side covering.

The supporting structure for greenhouses covered with film does not have to be as strong as those covered with glass or fiberglass. The bars and rafters on film-covered greenhouses may be spaced farther apart. If plastic film is going to be used to cover the greenhouse, a wire fabric should be installed beneath the plastic to serve as a support. Corrugated plastic and fiberglass should be attached to the purlins; the width of the sheet will determine the spacing of the purlins.

2. Materials Used to Cover Greenhouses

A number of different kinds of materials may be used to cover a greenhouse. Selection of a covering is based on (1) durability of the materials, (2) initial cost, and (3) maintenance costs. The material selected must permit a maximum amount of light and should allow the control and maintenance of the greenhouse environment.

A comparison of several greenhouse covering materials is provided.

Transparency No. 2

Glass - Glass is placed on the greenhouse similarly to shingles, except it is lapped only about one-fourth of an inch. The glass is set on a bedding compound, which has been applied to the sash bars, and is held in place by glazing points. After the glass has been set, the compound is also applied to each side of the bar and painted to make it waterproof. Maintenance costs can be reduced by bolting aluminum bar caps to the sash bars.

Every four to six years the glazing compound must be repainted to maintain a good seal and to prevent the compound from deteriorating. Periodic maintenance delays reglazing. All of the glass must be removed, the bars cleaned, new compound applied, and the glass relaid when the greenhouse is reglazed.

Glass cannot withstand hail; therefore, in areas subject to hail, a frame should be constructed above the greenhouse and covered with hardware cloth or chicken wire to protect it.

Plastic - Several types of plastics, both film and corrugated panels, are now available as greenhouse coverings, but there is some controversy as to their value. Plastic film permits adequate light transmission and is economical, but it is lacking in durability. The ultra-violet light rays cause the film to deteriorate, and it must be replaced in a short time.

Polyethylene film - This is the most widely used and cheapest covering material, but it deteriorates the fastest. When exposed to summer weather, polyethylene will last only about four months. An ultraviolet ray-resisting polyethylene film is available, but it is more expensive.

Glass prevents infrared radiation, while polyethylene allows the passage of heat energy from the soil and plants in the greenhouse. Polyethylene is easily torn and must be supported and held in place with other materials. Under Texas conditions it has a normal expected life of six months; therefore, it should be used only on temporary structures.

Vinyl film (Polyvinyl Chloride, PVC) - This film is more durable than polyethylene and will last one to two years under Texas' weather conditions; however, it is more expensive. Because of its static electrical attraction, PVC collects dust; thus, its light intensity is reduced. PVC is available also in rigid corrugated panels.

Mylar polyester film - Mylar film is a strong material with excellent weathering qualities, but it is very expensive. It costs as much as glass and lasts only three to five years. However, it costs less to install and maintain. Mylar is very noisy during a strong wind. Only type W mylar should be used.

Fiberglass panels - This is a relatively new material that has gained in popularity as a greenhouse covering. Several kinds of fiberglass are available. However, a 15% acrylic modified is recommended. The corrugations should be 2-1/2" x 2-1/2", and the roof covering should weigh five ounces per square foot. The four-ounce fiberglass may be used to cover the sides and ends of the greenhouse. The panel should be crystal clear with a light transmission of approximately 95% when tested in accordance with ASTM D - 1494. The surface finish should be smooth.

Fiberglass may have a higher initial cost than glass, but it is usually cheaper to install and maintain. It is made by imbedding glass fibers in acrylic resins. After weathering for several years, the fiber may become exposed, but the panels can be recoated with acrylic resin.

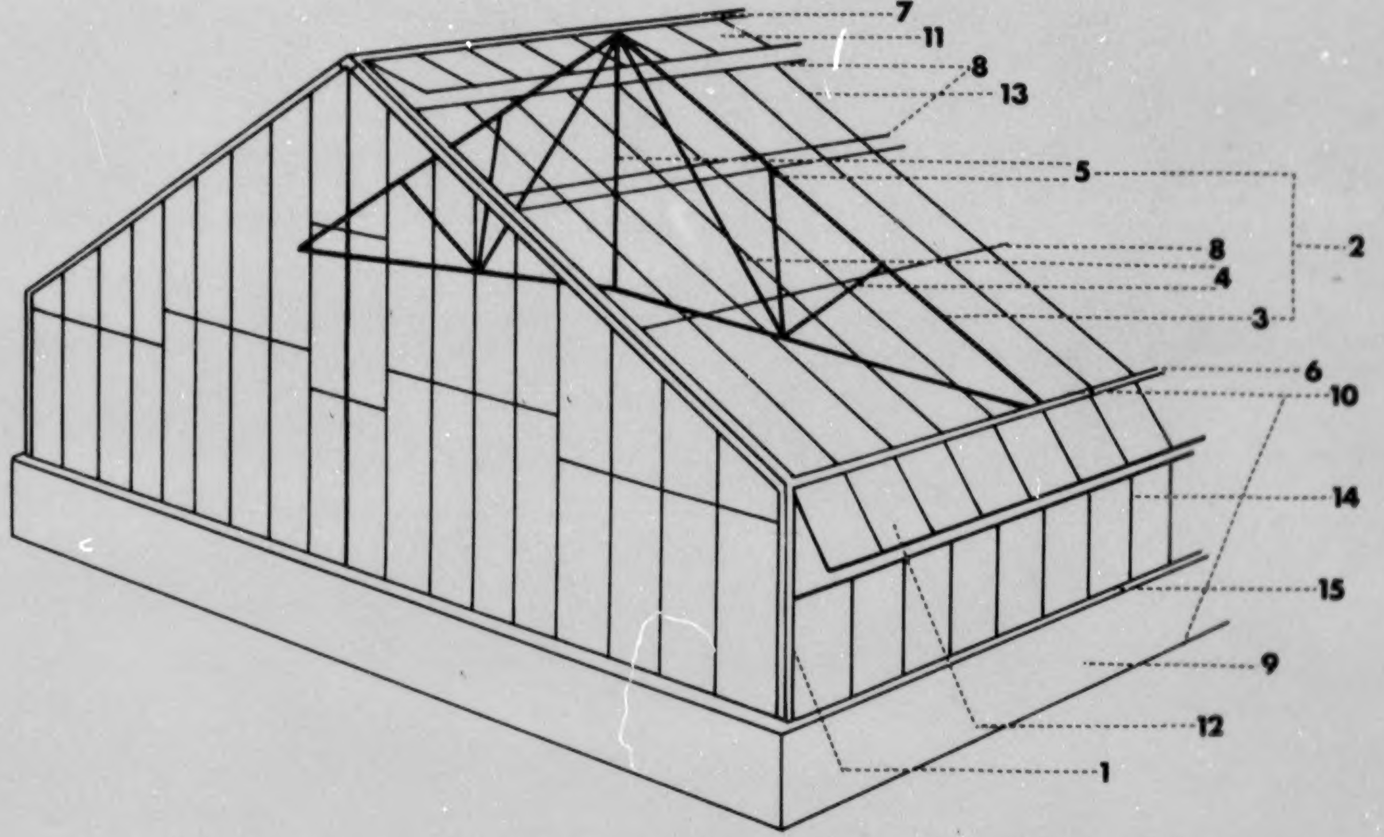
Fiberglass panels should be washed periodically to maintain their translucent qualities. When fiberglass becomes imbedded with dirt and grit, it loses the transmission of some of the light.

Humidity is usually higher in a fiberglass greenhouse because there is less air leakage. Ventilating fans may be used to overcome excessively high humidity.

References:

1. Laurie, Alex and others, Commercial Flower Forcing, McGraw-Hill Book Company, New York, 1969.
2. Hartmann, Hudson T. and Dale E. Kester, Plant Propagation, Prentice-Hall Inc., Englewood Cliffs, New Jersey, 1968.

PARTS OF A GREENHOUSE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1

A COMPARISON OF GREENHOUSE COVERINGS

MATERIAL	LIFE SPAN EXPOSURE TO FULL SUN	ESTIMATED COST PER SQ. FT.	CONSTRUCTION COST LABOR & MATERIALS	% LIGHT TRANS-MISSION	HEAT LOSS FACTOR[1]	HAIL RESISTANCE	PLANT GROWTH RESPONSE
Glass 26 oz.	Indefinite period	.32	$3.00/sq. ft. for 1000 sq. ft.; $1.50/sq. ft. by acre	96%	1.13 BTU plus loss through laps	Very low	Excellent
Polyethylene film 4 mil.	3 to 6 months	.0250	25% of cost of good glass construction	78%	1.6 BTU		Similar to glass
Vinyl film 8 mil.	1 to 2 years	.18	About 30% of cost of good glass construction	75%			Similar to polyethylene for first few months
Mylar Polyester film (Type W)	3 to 5 years	.32	50% of cost of glass construction	80%	0.92 BTU	Will withstand some hail	Similar to fiberglass
Fiberglass	Varies: claimed 10 to 15 years	.40 to .80	Somewhat higher than glass for good 15- to 20-year structure, 5 oz. with pipe frame	79% to 84%	0.92 BTU	Will withstand some hail	Better light diffusion than glass - some crops superior to glass

[1] Heat Loss factor is hourly heat loss in B.T.U.'s per sq. ft. in degree difference - indoors vs. outdoors.

CVAE AND VEH HORTICULTURE

Unit C: Structures and Equipment Used in Producing Greenhouse, Ornamental, and Nursery Plants

Topic 3: Greenhouse and Nursery Equipment

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Since "Electrical Applications for Greenhouses" provides a detailed explanation of the greenhouse heating system, the teacher may wish to acquire a copy of this publication from Vocational Instructional Services.

It is suggested that the teacher allow the students to observe the equipment used in a greenhouse in operation. Also, the student should be instructed in the setting-up and adjusting of equipment.

1. Greenhouse Equipment

A balance of environmental factors such as temperature, light, moisture, air, and nutrients must be maintained in the greenhouse in order for plants to make maximum growth. Since several pieces of equipment are used to balance the greenhouse environment, a grower must have a knowledge of use and operation of this equipment. In addition to equipment knowledge, the grower must be able to recognize the changes in environment that are taking place inside the greenhouse, as well as on the outside. Also, plant growth requirements are changing constantly. The following discussion is given to familiarize students with the different equipment used in the greenhouse.

Greenhouse Benches

Benches are placed in a greenhouse for two reasons: (1) to help control the environment around plants, and (2) to increase labor efficiency. The size of the greenhouse and the kinds of plants to be grown should be considered in selecting the greenhouse benches.

Transparency No. 1

Soil Filled Benches - Benches of this type are used to grow cut flowers directly in the soil. There are two kinds, ground and raised. Ground benches are constructed of concrete to prevent the soil in the benches from coming in contact with the ground. The benches are constructed with a V-bottom and a pitch of at least one inch per hundred feet of bench space. Sides of the ground benches should be deep enough to hold six inches of soil. The advantage of ground benches is the extra head room for the plants.

Concrete, wood, fiberglass, asbestos, steel, or a combination of these materials may be used in constructing raised benches. Either a V-bottom or slits may be used for drainage in this type. Raised benches are easier to work, provide better drainage, and insects and diseases are easier to control.

Regardless of the type used, consideration should be given to the width of the benches and a support structure above the benches for cloth and/or wire. The maximum width of benches is 4½ feet. Wider benches are most difficult to work.
Container Benches - Since container grown plants require good drainage and the free movement of air around the plants, the benches do not have sides. They are normally built about 30 inches above the ground. Different kinds of materials may be used in constructing the benches, but the bottom should not be solid. Expanded metal or one-inch, 14 gauge welder wire fabric makes an ideal bench bottom.

Watering and Fertilizing Equipment

Both hand watering and fertilizing and automatic equipment is being used. When watering and fertilizing by hand, a water breaker is used on the hose to prevent damage to the plants and to prevent disturbing of the media around the plants. A calibrated hose-on attachment is available for hand watering and fertilizing of plants. The attachment will allow the application of the desired mixture. However, there are several disadvantages for hand watering and fertilizing:

1. High labor cost;
2. Possibility of improper watering and fertilizing;
3. Causes compaction (leads to poor aeration and drainage. Using the proper mixture of peat and perlite in the media will prevent compaction. However, little water pressure may be used; and uniform watering cannot be attained.); and
4. Foliage damage may occur (wet leaves sometimes cause disease and/or fertilizer burn).

Several brands and types of automatic equipment are available for watering and fertilizing plants. Many of the systems can be used to feed and water nursery plants (containers and rows) as well. Automatic systems are referred to as injector systems and range in price from $300 to $1,000. They are calibrated from a ratio of 1:15 to 1:200 (one part of fertilizer to 200 parts of water). Injector systems may be purchased pre-set, or they may be set by the operator. To make a system completely automatic, an automatic water valve and time clock should be included in the system.

The initial cost of the system may be considered a disadvantage, but there are many advantages:

1. One bench or an entire greenhouse may be watered and fertilized at one time;
2. Reduces labor requirements;
3. Reduces soil compaction;

4. Reduces plant damage caused by hand watering;
5. Reduces the possibility of disease; and
6. Produces faster growing, more uniform plants.

As is true with any piece of equipment, maintenance is required to keep the system operating properly. The water and fertilizer system should be flushed and disinfected periodically.

Cooling Equipment

Plants usually stop growing when the atmospheric temperature goes above 90° F. The greenhouse temperature generally is about 20 degrees warmer than the atmospheric temperature unless some method of cooling is used. A properly installed cooling system can reduce the temperature inside the greenhouse from 95° to 75° F, an ideal temperature for growing plants.

The two systems used to cool greenhouses are called the "wet-pad exhaust fan system" and the "mist system." An explanation of each is given:

Transparency No. 2

Wet-Pad Exhaust System - This is an evaporation system which was originated by the Texas Agricultural Experiment Station and is reported to be practical, economical, and efficient.

Aspen or commercial pads, made of a composition fiber enclosed in a metal grid, are placed in a frame on one side or at the end of the greenhouse receiving the prevailing wind. Water is recirculated over the pads, and exhaust fans located on the opposite side or end draw cool air over the plants. All other air vents are closed while the fans are operating, and the equipment is controlled automatically by thermostats and humidistats. A commercial pad assembly may be purchased, or it may be constructed. Teachers have reported that commercial pads, made from corrugated paper, last longer.

Until recently, the pad systems have been placed in a vertical position; however, in some of the newer greenhouses, the pads are being placed in a horizontal position. The greenhouse operator planning to build a new greenhouse may want to consider the placement of pads horizontally.

A discussion of the different pieces of equipment needed to install a wet-pad exhaust fan system is as follows:

Exhaust Fans - To determine the number and size of exhaust fans needed, the operator must determine the rate of air flow, which should be from seven to ten cubic feet per minute per square foot of area covered. This is determined by multiplying the length X width of the greenhouse X cubic feet of air per minute of air flow. For example, a greenhouse 20 feet wide by 40 feet long by 7 (minimum cubic feet of air flow per minute) equals 5,600 cubic feet per minute. The fans in the greenhouse would need to pull a minimum of 5,600 cubic feet of air per minute. The maximum air flow needed for the greenhouse in the above example would be 8,000 cfm. All fans should be rated at 0.1 inch static pressure because of the pad pressure on air flow.

Air has a tendency to rise at the rate of one foot for every eight feet traveled; therefore, it may be necessary to install vertical plastic baffles every thirty to forty feet to redirect the airflow back over the plants.

Pad Area - Approximately one square foot of moist pad space is needed for each 150 cubic feet of air moved per minute. The size of pad area needed is determined by dividing 150 into the cubic feet of air flow in the greenhouse. For example, the greenhouse in the above example would have a minimum of 5,600 cfm. Dividing 5,600 by 150 = 37.3, the minimum number of square feet per pad area needed for the above greenhouse. The maximum amount of pad area needed would be 53 cubic feet. In order to have the proper air flow through the pads, two-inch thick pads are recommended.

Cooling System Recirculating Equipment - In order to reduce expenses and conserve water, recirculating equipment is used as a part of the cooling system. A list and explanation is given of each part of the recirculating equipment.

1. Float operated sump tank - This tank should be large enough to hold sufficient water to supply at least one-third gallon of water per minute for each linear foot of pad space. For example, a greenhouse with forty-two linear feet of pads would require a tank large enough to provide fourteen gallons of water per minute. Approximately three percent of the water will be lost to evaporation as it runs through the pads, but the float should keep an adequate supply of water in the tank. It is recommended that the tank be placed inside the greenhouse. This keeps the water cleaner and allows a much longer time between tank cleanings.

2. Pipe and trough (gutter) - A trough or pipe is installed above the pads to keep them moist. If a pipe is used, it should be four inches in diameter with three-sixteenth inch holes drilled four inches apart for the length of the pads. This size pipe is not needed in all greenhouses, but it will reduce the head pressure. Also, a trough or gutter is installed under the pads to return the unused water back to the sump tank.

3. Recirculating pump (sump pump) - The pump has to have sufficient capacity to deliver the required amount of water at the head. A pump that will supply 1-1/4 gallons of water per linear foot of pad is usually adequate.

4. Automatic controls for cooling system - Large greenhouses may need several thermostats set at slightly different temperatures to control the exhaust fans. As the temperature rises, more fans are turned on. In a small greenhouse having two or more fans, half of the fans should be operated by different thermostats. This prevents all of the fans from operating at one time.

   A humidistat set at seventy percent should control the sump pump. When the humidity is sufficient, the fans will circulate the air without the use of the water circulatory system.

The recommendations given below should be followed in maintaining the wet-pad exhaust cooling system:

1. Uniform wetness of pads - Household detergents may be used to insure uniform wetness of pads. The detergent should be placed in the sump tank. The amount to use will depend upon the hardness of the water used. An excessive amount will cause an abundance of foam.

2. Algae growth - This may be controlled by applying one tablespoon of Phygon to fifty gallons of water. Also, Shield (another commercial product) applied to the water at the recommended rate will control algae.

3. Pad replacement - Pads should be replaced when bare areas (hot spots) occur. This is usually every six to twelve months.

4. Pads - To prevent the pads from becoming clogged with debris and uncontrolled algae and to obtain maximum air flow, one should wash them every two weeks. This is accomplished with a forceful stream of water; the water should be directed to the pads from the inside of the greenhouse.

Mist System - This system produces a fine mist that evaporates without any water falling on the plants. The water pressure must be at a minimum of 500 pounds per square inch to produce the mist. Nozzles producing the mist are evenly spaced throughout the house.

In many areas of the state it is necessary to use shade in combination with the greenhouse cooling system to prevent excessive heat, reduce light intensity, and obtain maximum plant growth. This may be accomplished by applying a shading compound to the roof of the greenhouse, or by using a cloth - such as tobacco cloth, saran cloth, or muslin - to shade the plants in the greenhouse.

Greenhouse Heating Equipment

Greenhouses have special heating requirements since they are transparent, non-insulated structures that heat quickly during the daylight hours and cool just as quickly during overcast and dark periods. In order to respond quickly to a change in temperature, the heating system, as well as other equipment affecting the greenhouse environment (ventilation, humidity, and cooling equipment), should be operated by automatic controls. Because of the sudden variation in the temperature requirements within the greenhouse, the heating system should be designed by an engineer who understands the temperature requirements of plants and greenhouses.

The heat supplied to a greenhouse may be provided by a boiler, radiation, or forced-draft hot air. A discussion is given of each system.

Transparency No. 3

Boiler Heating System - The heat for this system may be supplied either by hot water or low pressure steam. Either system requires heating lines or pipes in the greenhouse. The pipes may be placed along the greenhouse walls, underneath the growing tables, or both. Sometimes some of the pipes are placed in the upper part of the greenhouse structure.

If steam is used, smaller and less expensive mains and heating lines may be used, and steam can be transported more efficiently for longer distances. However, the hot water system also offers some advantages.

Radiator Heating System - Electric or gas fired units are used with this system. In the older radiation heating systems, the heat was distributed from a boiler by radiation from bare or fin pipe.

Forced Draft Hot Air Heating System - This system is a recent development in heating greenhouses and is especially recommended in Texas, since gas is available in all areas. The heaters must be of sufficient size and mounted to supply a uniform heat (warm air) to all areas in the greenhouse. Two types of blowers are available - horizontal and vertical. The direction the shaft turns determines the type. The horizontal is used most often.

A recent development in heating greenhouses, attributed to a vocational agriculture teacher, is to mount the heaters to blow directly into a convection tube, which is closed on the opposite end. The tube provides for a uniform distribution of warm air throughout the greenhouse.

Greenhouse Ventilating Equipment

It is necessary during the winter to provide an adequate means of exchanging the greenhouse air with the outside air in order to regulate the greenhouse temperature, provide the proper amount of humidity and movement of air around the plants, and supply oxygen and carbon dioxide.

Many of the older greenhouses have ridge or eave ventilators or both; however, the newer greenhouses do not use this system of ventilation. However, the type of ventilation system will be determined by personal preference. Motor driven ventilator apparatuses controlled by thermostats are available to open and close the ventilators. When ventilators are used, cold air entering from outside is heavier and flows toward the base of the greenhouse after it enters the vents. The hot air rises and passes through the vents at the ridge or eaves.

Transparency No. 4

Air may be changed in the greenhouse with the fresh air convection tube system by fans and motorized shutters. The equipment used by this system is a plastic tube with pre-punched holes, exhaust fans, and shutters. The exhaust fans create a negative pressure and draw air into the greenhouse when the motorized shutters are open. The plastic tube system is operated by a thermostat that opens the shutters and starts the fan when the temperature reaches 70° F. The exhaust fan removes the warm air.

The fresh air convection tube system may be designed to provide continuous recirculation of the air within the greenhouse without the introduction of cool outside air when it is not needed. This continuous recirculation of the air in the greenhouse provides a more even temperature throughout the house and eliminates pockets of humid air near the leaf surfaces, which is favorable to foliage diseases.

Another automatic ventilation system used during the winter is the fan-jet or impeller system. It is similar to the fresh air convection tube system in that a convection tube is used. An impeller fan is placed between the outdoor inlet and the end of the plastic tube. The fan runs continuously and provides air circulation in the greenhouse at all times. Fresh air is admitted only when the thermostatically controlled shutters are open.

There is not a problem of CO_2 shortage in greenhouses in Texas, but in other areas it may be a problem and should be considered when planning the greenhouse ventilation system. CO_2 is necessary for photosynthesis, and plants are constantly using it. When ventilation equipment is operating, there is not a shortage of CO_2 in the greenhouse. However, during dark winter days when the ventilation system is not being used, there is a possibility of a lack of CO_2. Several makes of automatic greenhouse CO_2 generators are available that will provide the proper amount of CO_2.

Soil Sterilization Equipment

To be successful, the greenhouse operator must control the insects, diseases, viruses, and weed seed in the greenhouse soil. Normally, some type of soil sterilization equipment will be required. The proper time to select this equipment is before the greenhouse is built and while other equipment is being selected.

Steam, chemical, and electrical equipment are the three kinds used to sterilize greenhouse soils. The method selected will be determined by the type of heating system used in the greenhouse, the amount of soil to be sterilized, and the cost of the equipment and its application. A 240-volt soil pasteurizer is recommended for the pre-employment ornamental horticulture programs in Texas; however, a commercial operator may select steam or chemical equipment.

Steam is an economical method of soil sterilization in greenhouses heated with steam; some commercial growers use an electric steam generating unit. The type of chemical sterilization equipment to use will be determined by the type of chemical used. Chemical sterilization is recommended for the control of weed seed and soil-borne insects. It is not recommended as a soil sterilizer for bacteria, fungi, and virus organisms.

2. Greenhouse Plant Containers

At one time the clay flower pot was the only container used for marketing container grown plants; but several different kinds of pots, constructed from a wide variety of materials, are available to the grower of container plants. Most of the containers used for growing plants for resale are 4" in diameter or larger.

Transparency No. 5

Three different kinds of pots, based upon depth, are available. These are standard, azalea (referred to as 3/4 pots), and pans. The depth of a standard pot is the same as its diameter. For example, a pot 4" in diameter and 4" deep is referred to as a standard pot. Azalea pots are 3/4 as deep as their diameter. The depth of a pan pot is 1/2 its diameter. All three kinds of pots are available in sizes ranging from 2-1/4" to 14". Plastic pots are usually cheaper than clay pots, and less water is required by plants grown in plastic pots. Because of the loss of moisture through the pores in clay pots, plants growing in clay pots require from 1-1/2 to 2 times more water than plants grown in plastic pots. Plastic containers also are rapidly replacing tin cans which have been used many years to grow large greenhouse-and nursery-grown plants. Also available are many kinds of plant cubes and peat containers. These are generally used for propagating plants.

Transparency No. 6

Limited space prevents the listing of all the plant containers sold by different manufacturers. A few are listed for educational purposes. The ones listed are not recommended; neither is discrimination intended.

Several features of several kinds of containers are given in the following paragraphs:

Polytainers - This container is green, made of plastic, and is available in sizes ranging from one pint to six quarts. Since they will not freeze, rust, or decay, they are especially good for marketing nursery stock during all seasons of the year. Polytainers may be cut with scissors.

Hanging Containers - Possibly brought about by the increase in patio and balcony gardening in apartment complexes, there has been a large increase in the use of hanging containers. The two kinds available are hanging pots and hanging baskets.

Hanging pots are available in different sizes and may be made from either plastic or clay. The pot has advantages in that it does not have to be lined, and it has a built-in saucer which prevents it from dripping. These features make the pots more suitable for indoor and patio use.

There are two kinds of hanging baskets available - wire and plastic. They may be purchased with a diameter of 8" to 16". Sheet moss is recommended as a lining material.

Bedding Plant Containers - Since more containers are used for growing and selling bedding plants than for any other single use, there is a wide assortment of kinds and sizes available. Also, there are several kinds of containers made from peat, vermiculite, and plastic available for propagating plants. An explanation of several of these is as follows:

1. Jiffy Pots - There are two kinds: Jiffy-Strips and Jiffy-Pots. These are made of peat and a wood fiber and may be purchased as single pots or in strips. Plastic trays are available to hold the various sizes of strips to make them a sales item.
2. Plastic packs - Bedding plants may be grown in each of the plastic containers. Several sizes are available.
3. Cell-packs - This may be described as a series of plastic trays divided into a series of cells corresponding to individual pots. Each cell produces an individually potted plant.
4. Molded packs - These are made of molded fiber and impregnated with asphalt to make them last longer. They are available in several shapes and sizes.

3. Power Equipment

Large nursery operations require a large investment in power equipment. The amount, kinds, and sizes of equipment will depend upon the volume of business, size of nursery, crops grown, and to some extent, the personal preference of the nurseryman or greenhouse operator. A partial list of some of the equipment needed and a brief discussion of each is given below:

Transparency No. 7

The tractor is probably the most important single item of large equipment. Tractors are available in a number of sizes, but the medium size utility tractor in the

30 to 40 hp range is probably used by more nurseries. However, a very large nursery might have uses, especially when digging large trees, for a crawler type tractor. A number of attachments such as plows, harrows, cultivators, planters, root pruners, plant diggers, scoops, spreaders, mowers, sprayers, and dusters are available for most tractor models.

A small tractor, five to eight horsepower, can be used efficiently in the cultivation of nursery row crops. A number of attachments are available for the small tractor, and it can be put to many uses.

The power sprayer is a necessity for the control of insects and diseases of nursery stocks. A number of factors should be considered in determining the kind and capacity to purchase.

A self-propelled plant digger is used by large nurseries. The size of nursery, the size of plants to be dug, and several economic factors would determine the feasibility of purchasing this type digger. Digger attachments are available for medium size tractors.

Another item of equipment used by many nurseries is the fork lift. They are particularly useful in loading and unloading heavy objects.

Although the root pruner is not an item of power equipment, it should be listed because of its extensive use by nurserymen. A root pruner attachment is available for most medium sized tractor models. It is used to give the plant a compact root system, which makes digging, handling, and planting easier. Root pruning is accomplished by passing a U-shaped metal strap under the row of plants while pulling it through the soil.

4. Hand Tools and Equipment

Transparency No. 8

Small power equipment and hand tools are used extensively in the nursery and greenhouse businesses. A discussion of some of the most important items of power equipment is given below.

A garden tiller is very useful in preparing seedbeds and for the cultivation of small areas to control weeds.

Sterilization equipment is a necessity for all nurseries and many greenhouse operations. Soils must be sterilized to prevent the spread of disease and to successfully grow plants for a long period of time. The amount of soil to be sterilized and method of sterilization will determine the size and type of equipment to buy. A steam sterilization unit is the most efficient for sterilizing large volumes of soil.

A cement mixer can be used very effectively in the mixing of media. A manure spreader also has been used successfully to mix large quantities of media, and the spreader may serve as a means of transporting the media from one area to another.

Nurseries and greenhouses that sell a lot of potted plants should purchase a media machine, to be used for packing media in pots. There are a number of machines built by different manufacturers.

The power conveyor is a piece of power equipment that may be used to improve the efficiency of handling plants and supplies.

Shredders are useful in shredding leaves and waste materials and in preparing compost and media. The capacity of a shredder is expressed in the number of bushels it will shred in an hour.

A partial list of hand tools used in the nursery and greenhouses is as follows:

Transparency No. 9

Spades-several types are available. The most common are the square or the diamond point. Either point may be obtained with a straight or D-Handle.

The straight shanked is better for digging holes with vertical sides.

Spading Fork - These are available in several tine lengths. It is used for breaking up the soil in small flower beds.

Rake - Several different sizes are available. It is used to level soils and to separate decayed materials from soil.

Weed and Grass Cutter - The blade is sharpened on both sides, and the operator slings it back and forth to cut the weeds and grass.

Hoes - These are available in several different styles and are used to remove weeds from flower beds and other areas.

Trowels - Numerous types of trowels are manufactured. They are used in potting, mixing small quantities of soil, and transplanting.

Transparency No. 10

A number of different kinds of hand tools are used in pruning and caring for plants.

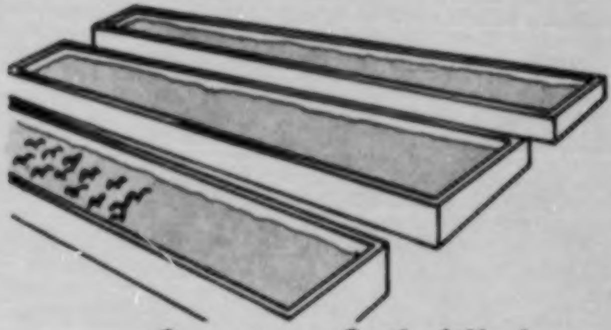
References:

1. "Greenhouse Crop Production," Pennsylvania State University, Vol. 10, No. 35, 1969.

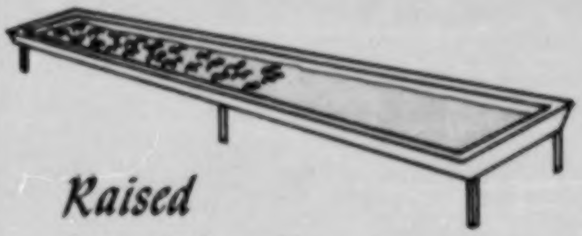
2. Laurie, Alex, and others, Commercial Flower Forcing, McGraw-Hill Book Company, New York, 1969.

3. "Electrical Applications for Greenhouses," Vocational Instructional Services, Texas A&M University.

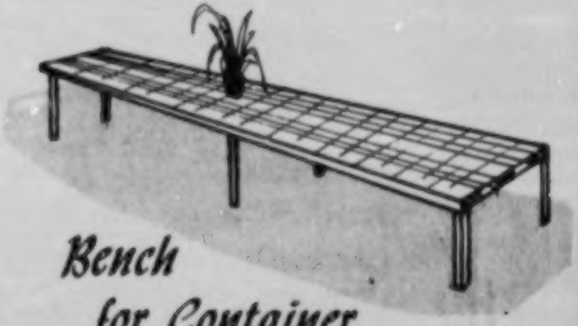
GREENHOUSE BENCHES



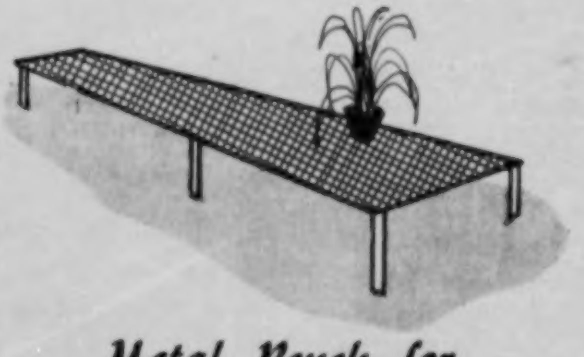
Concrete Soil-filled Ground Benches



Raised Soil-filled Bench

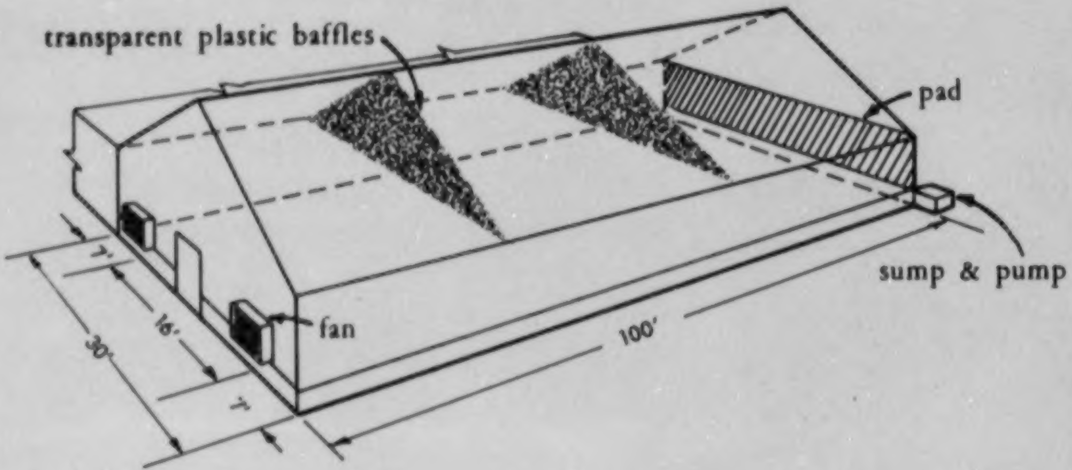


Bench for Container Grown Plants

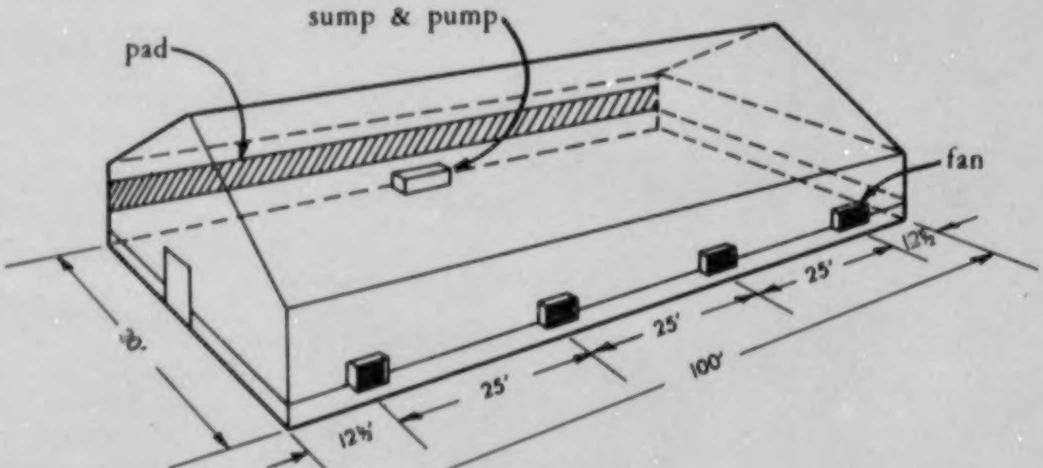


Metal Bench for Container Grown Plants

WET-PAD EXHAUST FAN COOLING SYSTEM

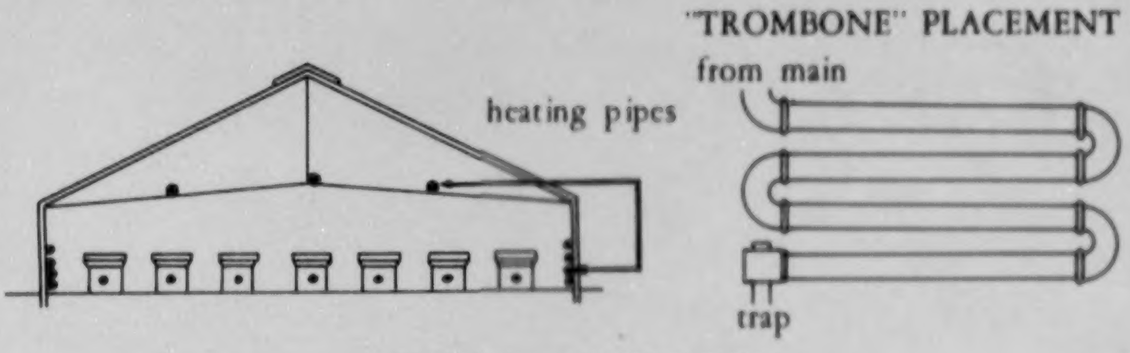

transparent plastic baffles
pad
sump & pump
fan
7'
16'
7'
30'
100'

PADS & FANS ON THE ENDS OF THE GREENHOUSE

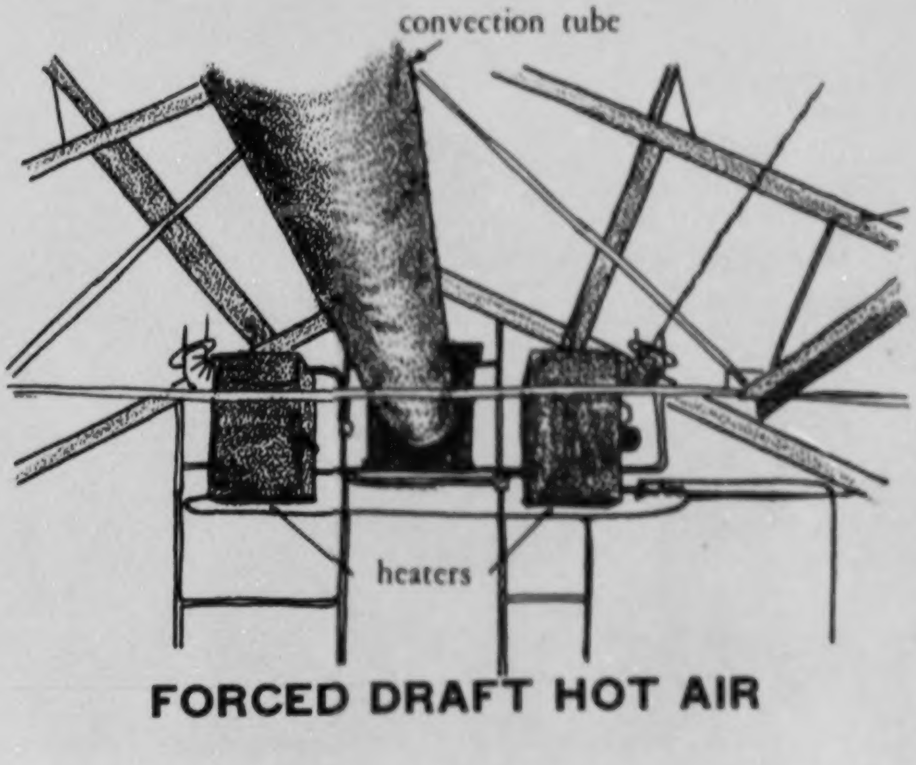

sump & pump
pad
fan
30'
12½'
25'
25'
25'
12½'
100'

GREENHOUSE WITH FANS & PADS ON THE SIDES

TYPES OF HEATING SYSTEMS

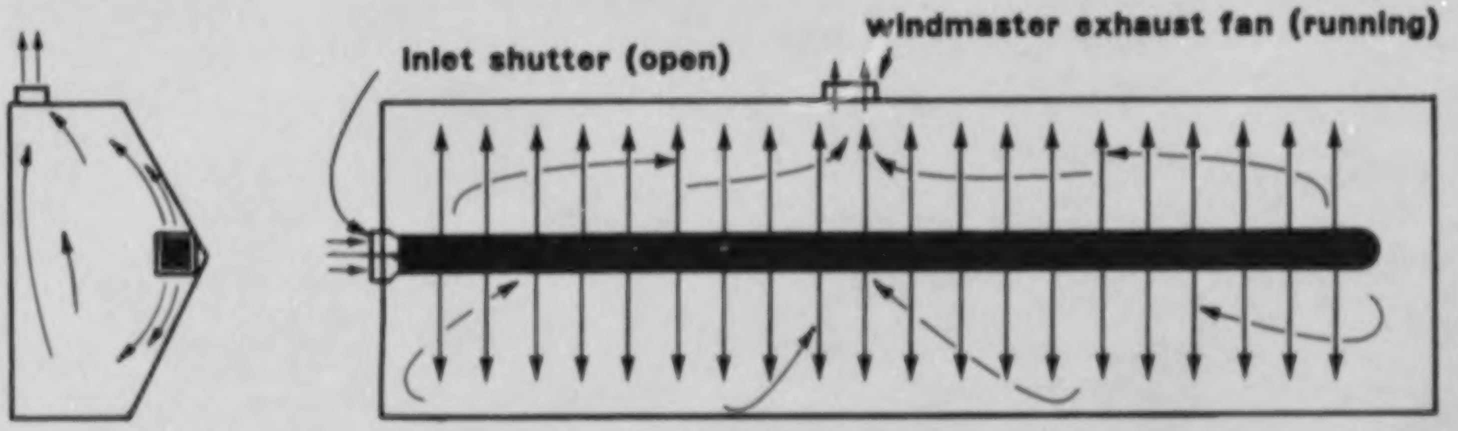

"TROMBONE" PLACEMENT
from main
heating pipes
trap

BOILER SYSTEM

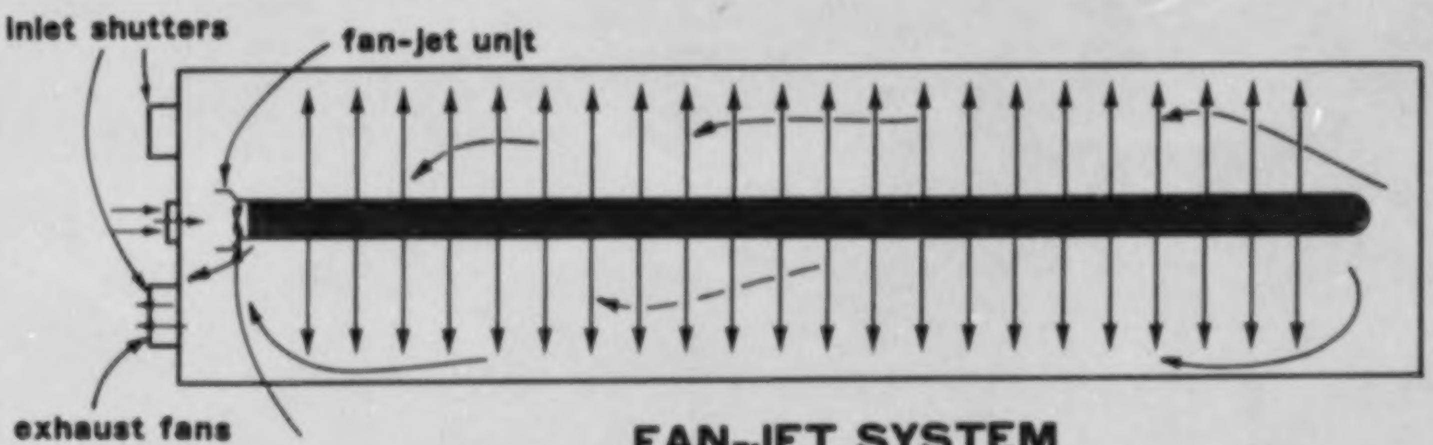

convection tube
heaters

FORCED DRAFT HOT AIR

TYPES OF GREENHOUSE VENTILATION SYSTEMS

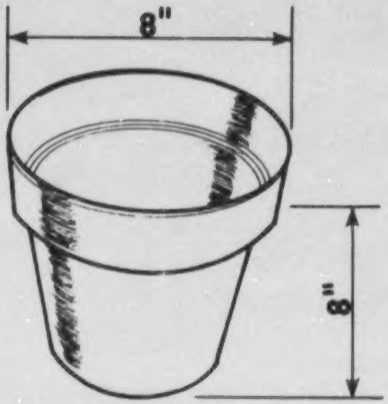

windmaster exhaust fan (running)
inlet shutter (open)

FRESH AIR CONVECTION TUBE SYSTEM

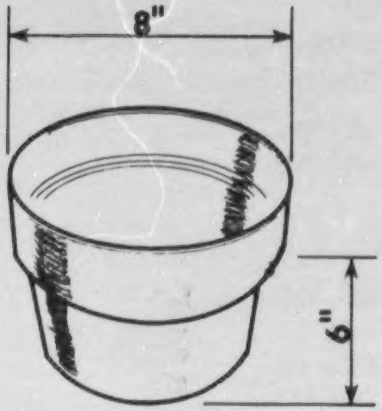

inlet shutters
fan-jet unit
exhaust fans

FAN-JET SYSTEM

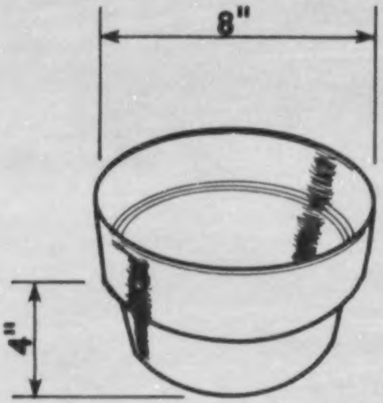
KINDS OF POTS BASED ON DEPTH



STANDARD

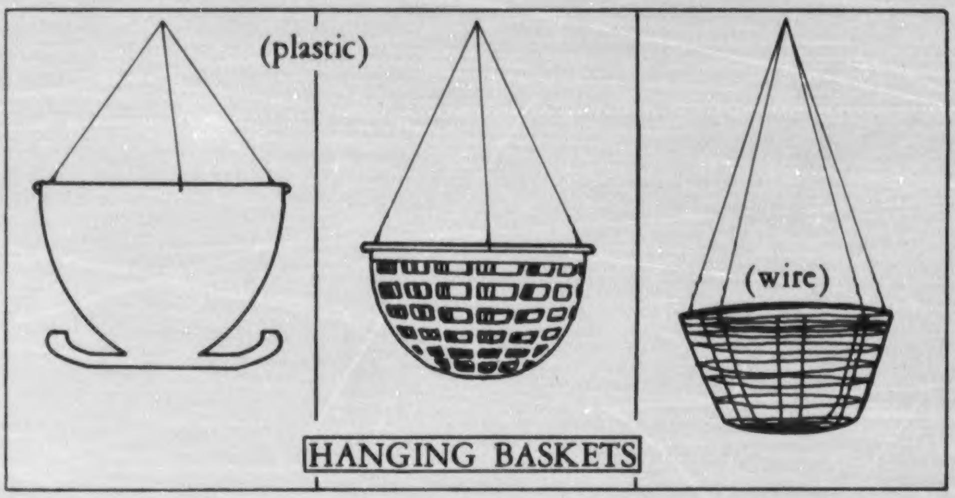


AZALEA

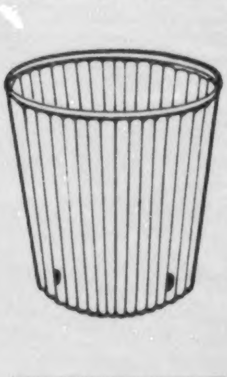


PAN

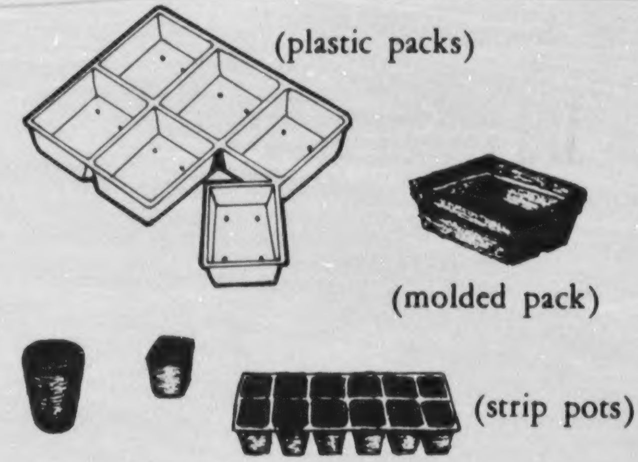
CONTAINERS FOR GREENHOUSE & NURSERY GROWN PLANTS


(plastic)
(wire)

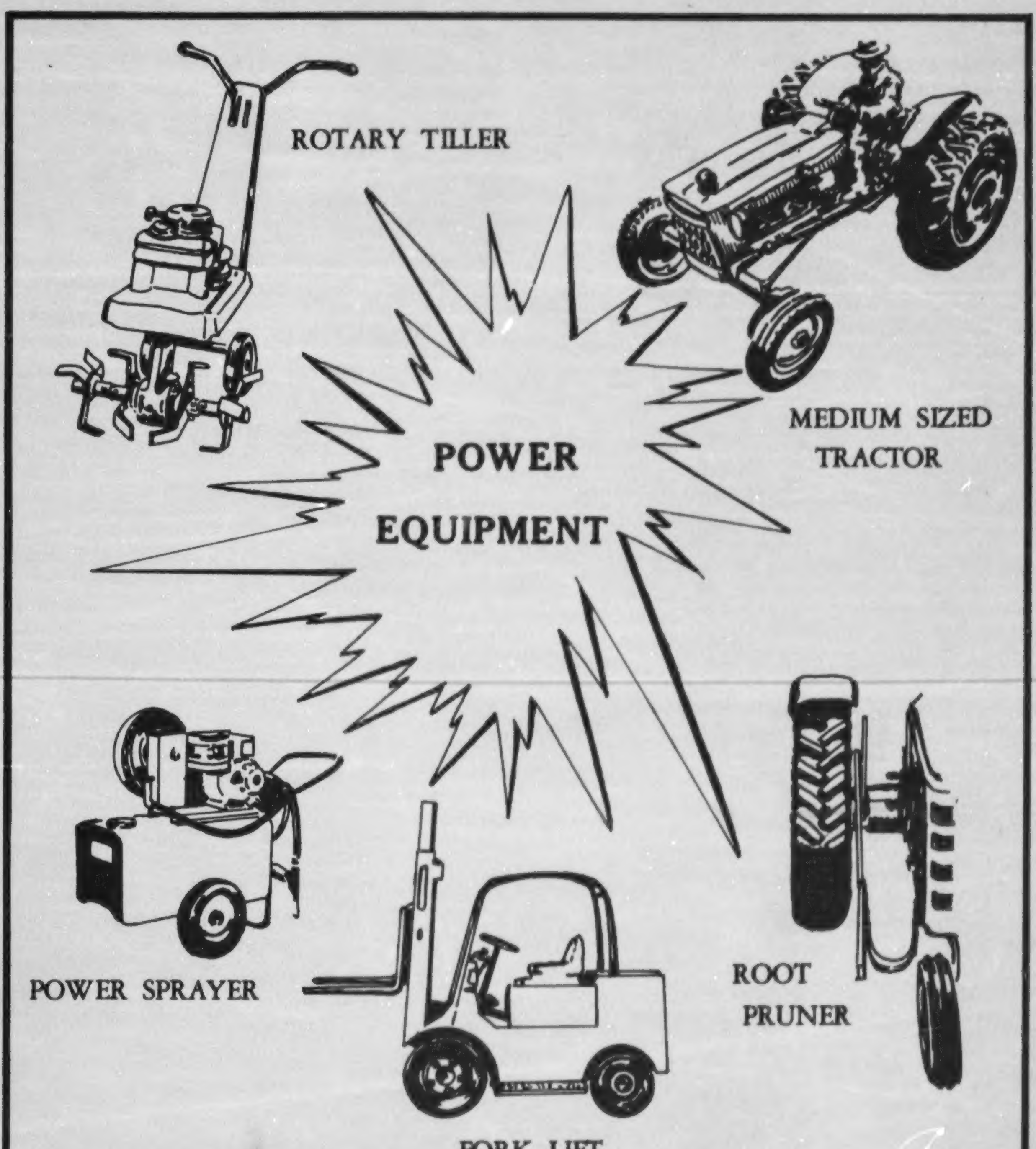
HANGING BASKETS



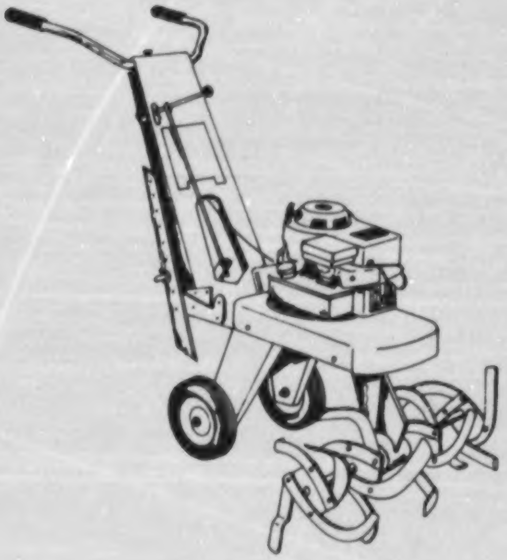
POLYTAINER


(plastic packs)
(molded pack)
(strip pots)

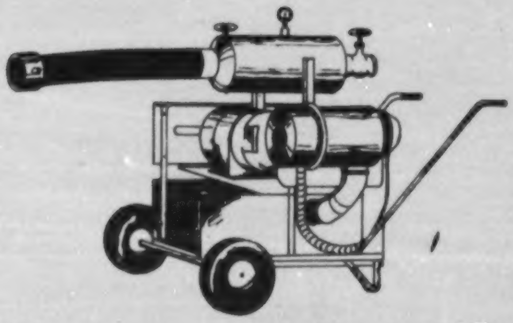
BEDDING PLANT CONTAINERS


ROTARY TILLER
MEDIUM SIZED TRACTOR
POWER EQUIPMENT
POWER SPRAYER
ROOT PRUNER
FORK LIFT

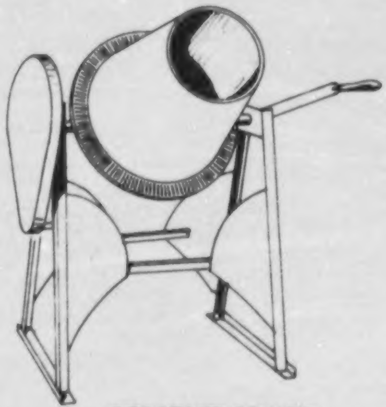
EQUIPMENT



GARDEN TILLER



STEAM STERILIZATION UNIT



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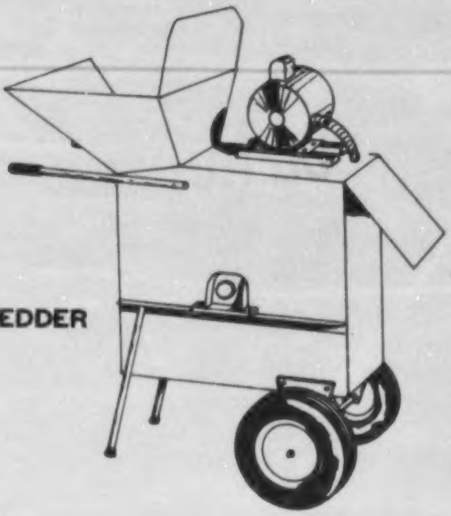
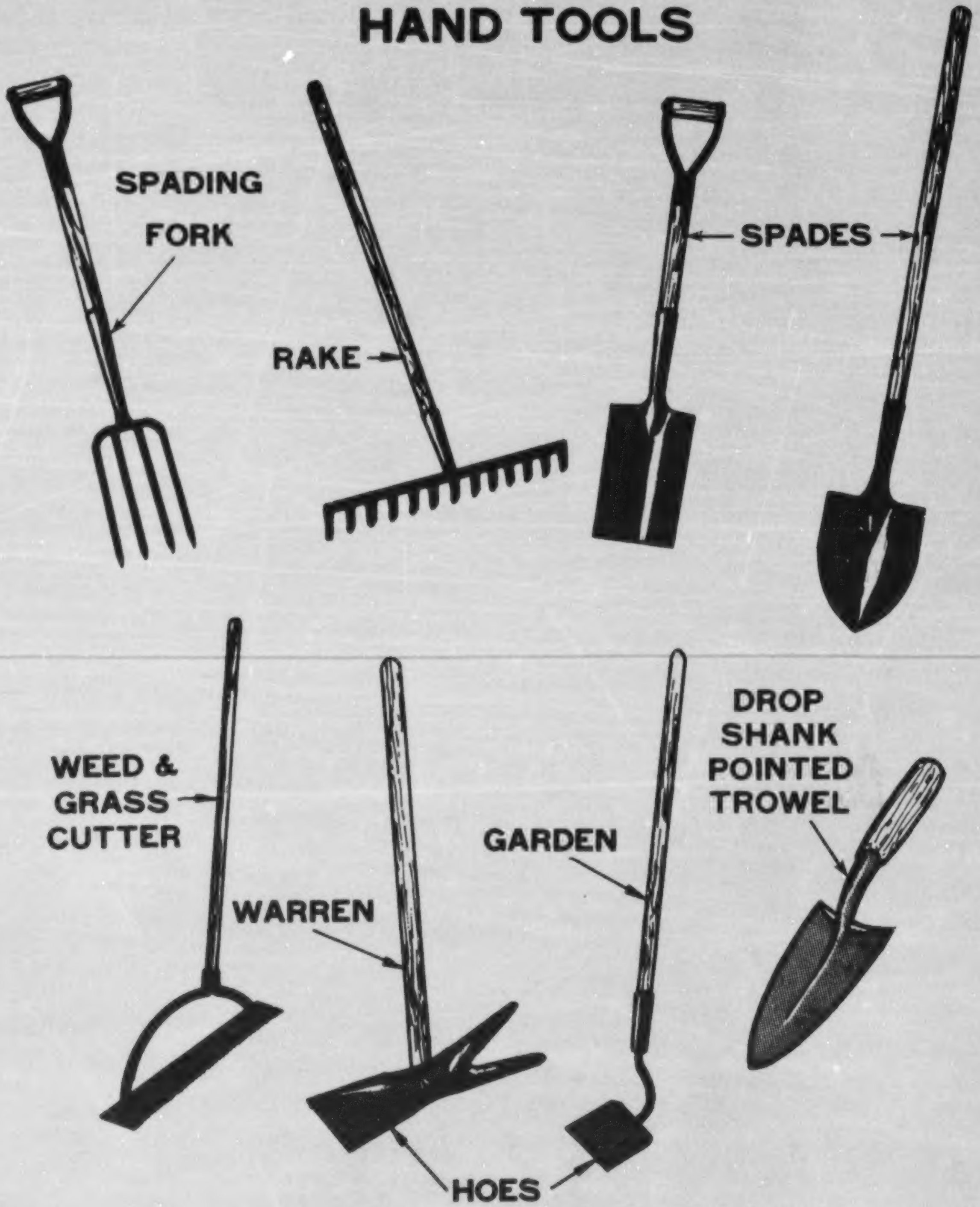
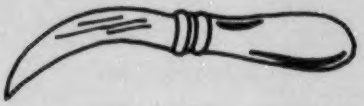


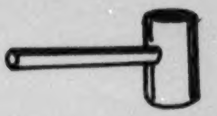
SHREDDER

HAND TOOLS


SPADING FORK
RAKE
SPADES
WEED & GRASS CUTTER
WARREN
GARDEN
DROP SHANK POINTED TROWEL
HOES

HAND TOOLS


PRUNING KNIFE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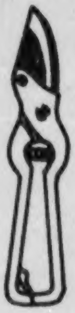
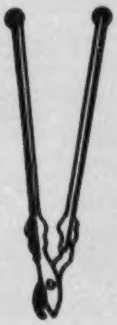
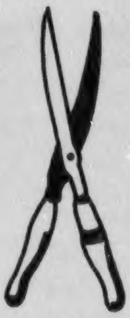
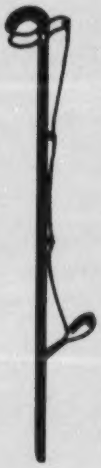
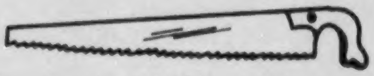
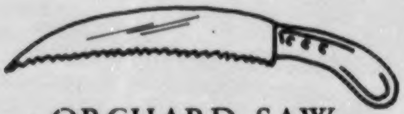

PRUNING SHEARS

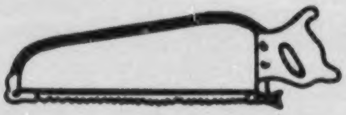

LOPPING SHEARS

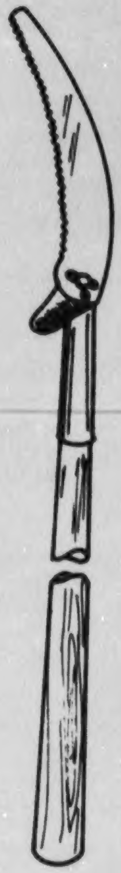

HEDGE SHEARS


POLE PRUNER


PRUNING SAW


ORCHARD SAW


TAPERED SAW


POLE SAW

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Agricultural Education

C-4
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit C: Structures and Equipment Used in Producing Greenhouse, Ornamental, and Nursery Plants

Topic 4: Determining Location, Size, and Arrangement of a Greenhouse

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

It is suggested that the class visit several greenhouses and observe the factors discussed in the topic. Most greenhouse operators will be glad to point out the mistakes they made in selecting the site.

1. Selecting the Greenhouse Site

The importance of selecting the site for the greenhouse cannot be overemphasized, for the greenhouse generally is a permanent structure. Constraints exist on most any site; but by careful evaluation, a person can select a site that will meet the requirements for growing plants. Several factors should be considered in selecting a site.

Transparency No. 1

Site Topography, Buildings, and Other Obstructions - Locations of structures on adjacent property should be considered. The greenhouse should not be located downwind from a heating plant, incinerator, or laboratory emitting toxic fumes. Because of high winds, the top of a hill should be avoided for a site. An ideal greenhouse site is often near the center of a long slope.

Another consideration is a history of the weather in the area. Some areas are noted for having hail storms, while only a few miles away it seldom hails. Obviously, the greenhouse should not be located near a playground or playing field.

Still another consideration for the proposed site is the location of buildings and trees in the area. An area should be selected that will not be shaded by trees or buildings. Deciduous trees are not as much of a problem as evergreens. In fact, in some areas of Texas the sunlight is too intense during the summer months. Shade at the proper time of the day might be helpful. After losing their leaves in the fall, deciduous trees allow enough sunlight to enter the greenhouse.

Orientation of the Greenhouse - This refers to how the greenhouse is placed on the site. It is important because it affects the amount of sunlight entering the structure and the heating and cooling efficiency. It is recommended that the greenhouse be placed on the site with the ends facing north and south. This allows each side of the structure to receive the maximum sunlight and an equal amount. Growers report that there are considerable differences in the growth of plants from one side of the greenhouse to the other when the structure is not placed on the site in the recommended manner. The doors of the greenhouse should not open into the prevailing wind.

Light Exposure - Kinds of plants grown and availability of sunlight during the winter determine the amount of light exposure required. Orchids, African violets, and foliage plants do not require as much sunlight as some other plants. If several different kinds of plants with different light requirements are to be grown, the greenhouse should be oriented to allow the entrance of the maximum amount of sunlight.

Operating Cost - The site can affect the cost of heating and cooling the greenhouse. These costs should be considered in selecting the site.

Wind Direction - The amount, size, and placement of ventilation equipment is determined by the wind direction. The grower should be familiar with the wind direction before placing the greenhouse on a site.

2. Determining the Size of the Greenhouse

The principal factor to consider in determining the size of the greenhouse is the crop to be grown. Pot plants are easier to grow in small greenhouses, while cut flowers are more easily grown in a large greenhouse.

Transparency No. 2

Another factor in determining greenhouse size is the table arrangement. The arrangement is also determined by the crop to be grown. The three most popular arrangements are the peninsular, longitudinal, and combination.

The peninsular arrangement provides more usuable bench space and requires less walking; therefore, it is considered to be the most efficient arrangement.

Economy of construction should be considered in determining size. Some structures are more economical to build than others. The ridge and furrow style is usually more economical to build, but the temperature is more difficult to control. Also, the gutters shade some areas in the greenhouse.

The framework and covering will affect the size of greenhouse to be constructed. Strength and durability are determined by the framework used. A framework of steel or aluminum should be used in the construction of permanent greenhouses.

The width and length of the greenhouse are important considerations in determining size. The width is more important than the length, since the greenhouse walls are permanent. Room for expansion should be left at the ends of the greenhouse.

Labor efficiency is another factor to consider in determining greenhouse size. A certain amount of labor is required in the handling of plants, and labor cost is a major item of expense in the production of any greenhouse plant.

If after considering the above factors one is still undecided as to the size of greenhouse to build, there are several advantages in building several small greenhouses rather than one large one. Small greenhouses allow for compartmentalization, are much easier to heat, cool, and maintain the temperature, and make possible a wider diversity of crops.

3. Greenhouse Arrangement

Since the greenhouse arrangement will affect plant production, the greenhouse should be arranged to grow the maximum number of high quality plants for twelve months of the year. Aisles and walkways should be wide enough to permit the use of carts, sprayers, and other equipment. The arrangement should also prevent posts and supports from shading and restricting the growth of plants.

The temperature and light requirements of plants will affect the arrangement. If several different kinds of plants are grown in the greenhouses, they may have different light and temperature requirements. Two different environmental control areas may be needed in the greenhouse. There is a tendency by many greenhouse operators toward the use of less environmental controls. This is due to the increase in the costs of gas and electricity.

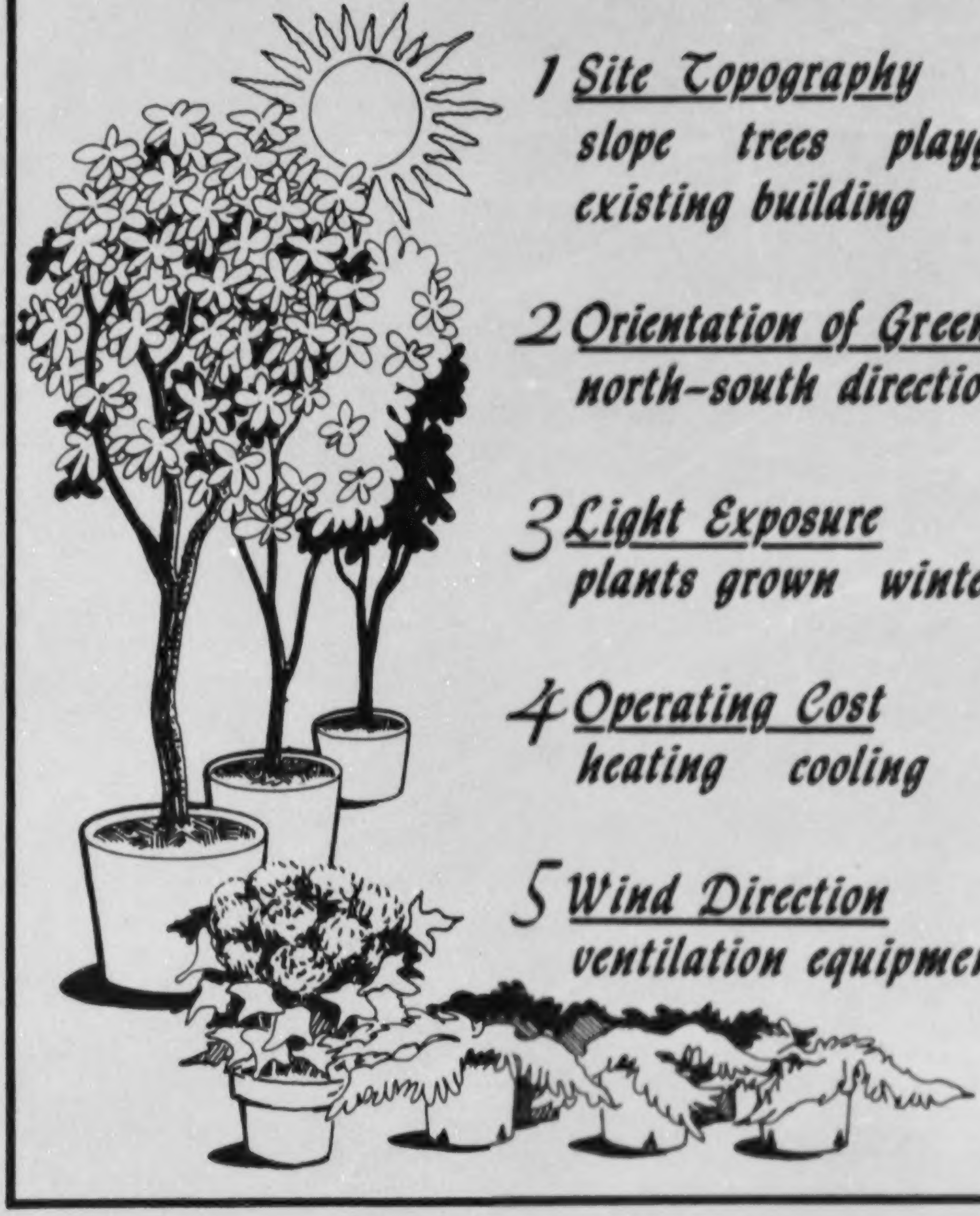
Transparency No. 3

One greenhouse arrangement is shown in the above transparency. It has four different environmentally controlled areas and allows for the production of a wide range of greenhouse plants.

Reference:

Laurie, Alex, and others, Commercial Flower Forcing, McGraw-Hill Book Company, New York, 1969.

SELECTING A GREENHOUSE SITE



1 ***Site Topography***
slope trees playgrounds existing building

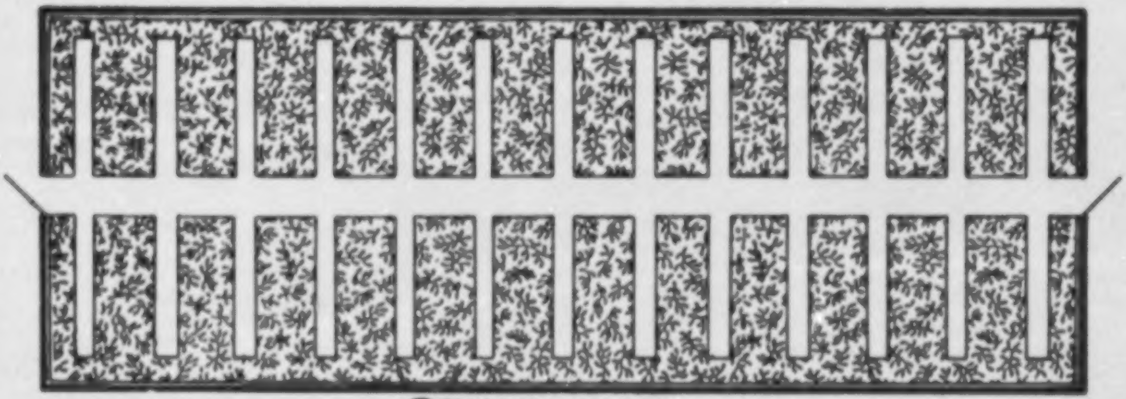
2 ***Orientation of Greenhouse***
north-south direction

3 ***Light Exposure***
plants grown winter sunlight

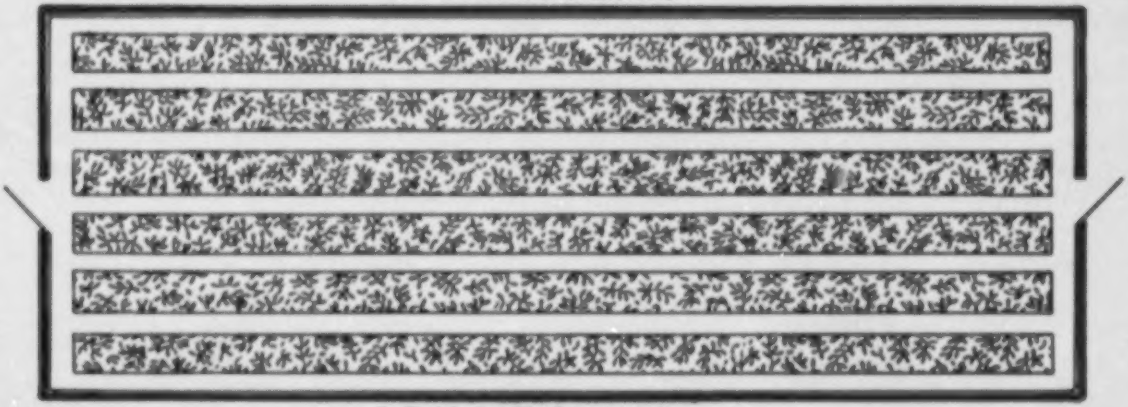
4 ***Operating Cost***
heating cooling

5 ***Wind Direction***
ventilation equipment doors

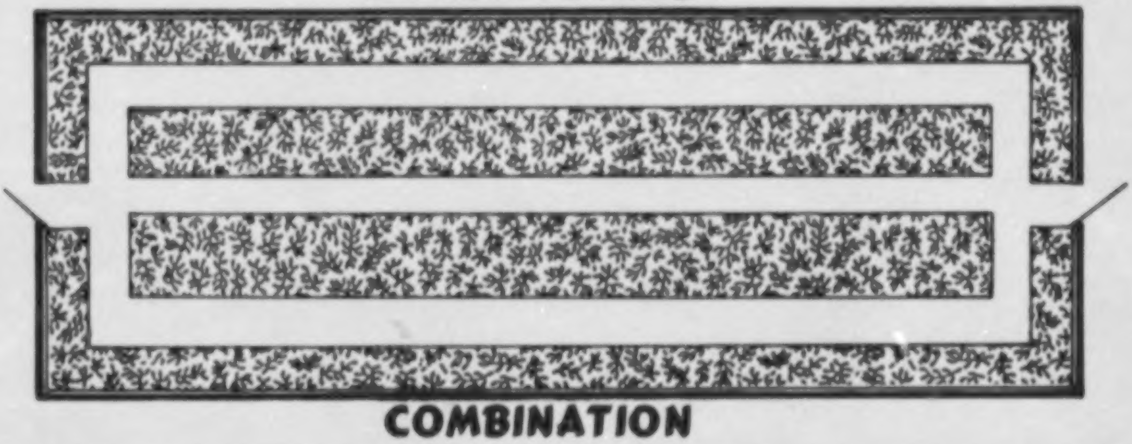
GREENHOUSE BENCH ARRANGEMENTS



PENINSULAR

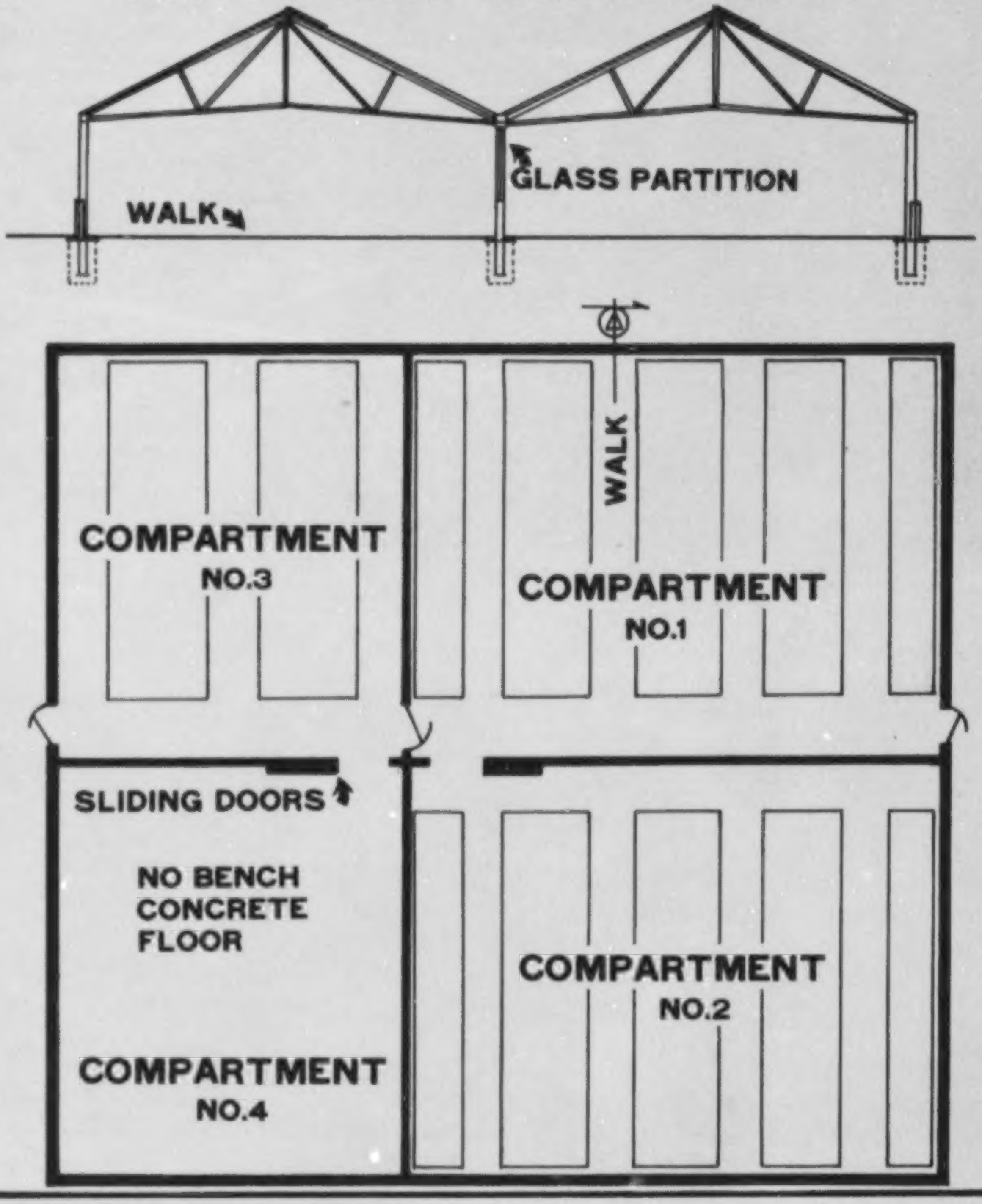


LONGITUDINAL



COMBINATION

GREENHOUSE ARRANGEMENT


GLASS PARTITION
WALK
WALK
COMPARTMENT NO.3
COMPARTMENT NO.1
SLIDING DOORS
NO BENCH CONCRETE FLOOR
COMPARTMENT NO.2
COMPARTMENT NO.4

Vocational Instructional Services
Agricultural Education

D-1
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CVAE AND VEH HORTICULTURE

Unit D: Greenhouse Environment

Topic 1: Environmental Controls

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

If possible, students should be given the opportunity to observe and handle the equipment used to control the greenhouse environment.

1. Greenhouse Temperature Control

The most important single factor in operating a greenhouse is being able to accurately control the temperature. There is a limited temperature range in which plants will make rapid growth and development. Also, there is a desirable temperature for each type of plant grown and for each type of growth desired.

It has been established that most plants will grow in a temperature range of 45° to 90° F., with an optimum temperature being around 70° F. Growth in most plants is greatly retarded or discontinued when the temperature falls below 45° F. or rises above 90° F.

Most greenhouse plants are classified as to an ideal growing temperature for nighttime and daytime. The daytime temperature depends upon weather conditions (whether it is cloudy or bright sun), but generally it should be 5° to 10° F. higher than the nighttime temperature. In order to maintain and regulate the greenhouse temperature, sensing devices are used.

Sensing Devices - Devices used by growers to control the greenhouse temperature are thermometers and thermostats. The thermometer is a sensing device that registers the temperature, and the thermostat is an automatic sensing device used to regulate the temperature by supplying electricity and/or gas for operating cooling and heating equipment.

The atmosphere and plant temperatures generally are assumed to be the same. To insure that these temperatures are the same and to regulate the temperature, the grower should follow certain principles regarding the use of thermometers:

Transparency No. 1

1. More than one thermometer should be used in the greenhouse. The thermometers should be located to determine the temperature difference from one end of the greenhouse to the other and from one side to the other.

2. The thermometers should be placed at plant level. The thermometer should be placed at bed level when plants are grown in ground beds.
3. The thermometers should be mounted so that the direct rays of the sun do not shine on the thermometer bulbs. The thermometers should be mounted on wooden boards and oriented to the north. This will help in adjusting the thermostats.

During the seasons of the year when there are drastic changes in the day and night temperatures, it is possible that both the cooling and heating equipment will operate during a 24 - hour period. It is also possible for them to operate at the same time. To prevent the heating and cooling equipment from operating at the same time, the grower should apply the following rules in determining the number and location of thermostats.

1. Four thermostats should be installed--two for the fans and two for the heater. These should be placed near the center of the greenhouse and at plant height for best results.
2. Of the two thermostats connected to the fans, one should control one-half of the fans and be set to operate at 65° F.; and other thermostat should operate the other half and be set to operate at 70° F. This keeps all of the fans from operating at one time.
3. The thermostats connected to the heaters should be installed in the same manner as those connected to the fans and operate at the same temperatures. Because each set of thermostats operates independently of the other set, the temperature is much easier to control.

Many greenhouse operators use a perforated plastic ventilation tube with a motorized shutter to cool the greenhouse during the winter. Certain operating principles should be followed when this system is used:

1. The fan on the ventilation tube should run continuously. This prevents cold areas in the greenhouse and circulates warm air uniformly.
2. The motorized shutter, located at the open end of the ventilation tube, should be controlled by a fan thermostat and set at 70° F. This causes cool air to be drawn into the greenhouse when the temperature reaches 70° F., and at the same time warm air is being removed by the exhaust fan(s). Also, the heater will warm the cool air as it is drawn into the greenhouse.

2. Controlling the Humidity

The relative humidity is a measure of the amount of water vapor in the atmosphere at a given temperature and must be controlled along with the temperature. An example is given to clarify the term relative humidity. A relative humidity of 70%, at any temperature, means that the atmosphere has 70% of the moisture that it is capable of holding at that temperature. Warm air has a greater capacity for holding moisture than does cold air; therefore, to maintain a relative humidity in a higher temperature, more water must be evaporated. Sometimes as the temperature drops in the greenhouse, relative humidity increases and a condensation of moisture forms on the plants. This is undesirable. There are several reasons the relative humidity should be controlled in the greenhouse:

1. To prevent the spread of diseases such at Botrytis blight and powdery and downy mildew that multiply when the relative humidity is high
2. To maintain the proper rate of transpiration
3. To maintain the proper rate of photosynthesis

For optimum growth, most greenhouse plants require a relative humidity of about 70%. A humidistat, a relative humidity sensing device, is used to operate the equipment for raising the humidity in the greenhouse. Even though the systems used to provide humidity are also a part of the cooling system, the humidistat should operate independently of the cooling systems. By operating independently of the cooling system, the exhaust fans can circulate air without drawing moisture into the greenhouse unless it is needed.

The methods that may be used to increase relative humidity are as follows:

1. Wet aspen pads; this system is controlled by the humidistat.
2. High pressure mist system; the system is controlled with a humidistat.
3. Hand mist plant foliage and walks.

3. Controlling Light in the Greenhouse

Light is one of the most important environmental factors influencing plant growth. Since light varies in intensity, duration, and quality, the grower must be able to control it.

Light intensity (brightness) affects the photosynthetic processes, and light duration (day-length of light) is an important factor in plant development. Light quality (amount of color in the light spectrum) affects plant growth. "White" light is a mixture of light colors and is the best for growing plants.

Transparency No. 2

Plants have a light preference and can be classified into three groups, which are as follows:

1. Maximum or a highly intense light
2. Intermediate light or partial shade
3. Low light intensity or full shade

Because of the light preference of plants and the need to provide the proper lighting in order to grow plants, it is necessary that lighting in the greenhouse be controlled.

Plants having a highly intense light requirement prefer 4,000 to 8,000 foot-candles (for an average day-length) for growth; however, they may be maintained on 500 to 2,000 foot-candles.

Plants in the intermediate group prefer 1,000 to 3,000 foot-candles (for average day-length) for growth, but will survive on 100 to 1,000 foot-candles.

Plants requiring a low light intensity prefer 50 to 1,000 foot-candles (for average day-length) for growth, but will survive on ten foot-candles.

Under normal conditions in Texas, low light intensity does not exist if the greenhouse is oriented and constructed properly. Too much light is generally the problem, especially during the summer months. Ligh intensity may be reduced in several ways:

1. Shading compounds - These may be used on greenhouses covered with glass but should not be used on fiberglass.
2. Shading with a cotton cloth (cheese cloth) - This will reduce light as much as 10% to 15%.
3. Shading with muslin or tobacco cloth - This will reduce as much as 50% of the light.
4. Shading with Saran - This material may be purchased with varying degrees of shading.

Controlling Soil Moisture - Establishing guidelines for determining the proper time to water greenhouse plants is one of the most difficult environmental factors with which the grower must contend. Because of the many varying factors involved, there are not any satisfactory rules that one can follow; however, the rules below are sometimes helpful in determining when to water:

1. Usually plants should be watered when the soil will crumble easily and form a wad or ball when it is compressed in the hand.
2. The soil will probably need watering if a clean trowel or bamboo cane is inserted in the soil and there is resistance or grating of the instrument when it is withdrawn. The instrument also should be free of soil particles when it is withdrawn.

Several factors may affect the time and frequency of watering.

1. Soil or media mixture - Heavier soils, because of their water retention capacity, require less frequent watering.
2. Temperature - As the temperature rises, there is an increase in the evaporation of soil and plant moisture, and the plant becomes dry more rapidly.
3. Containers - The soils in pots dry much quicker than the soils in benches or beds.

Amount of Water to Use - When soils are watered, enough water should be applied to drain through the container, whether the container is a bench, flat, or pot. This will usually thoroughly moisten the soil and prevent an excessive salt build-up.

Methods Used to Apply Soil Moisture - Soils may be watered from the top or bottom, either manually or by automatic waterers. Top watering is the most common method because the soil can be flushed while the plants are being watered.

Manual watering is usually the method used for watering cut flowers or pot plants that do not require daily watering. A hose and water breaker are used to apply the water. If this method is used, the water pressure should be great enough to water the plants in a reasonable length of time, yet not so great as to wash the soil or splash it on the plants.

An automatic watering system is usually used for plants that require watering daily or more often. The system is operated by a time clock, and the water should be applied early enough in the day to allow for the evaporation of excessive moisture before night. The equipment needed to install an automatic water system is discussed in Topic C-3 of these materials.

References:

1. Laurie, Alex and others, Commercial Flower Forcing, McGraw-Hill Book Company, New York, 1969.

2. DeWerth, A. F., "Greenhouse Problem Diagnosis."

USING THERMOMETERS AND THERMOSTATS

- MORE THAN ONE SHOULD BE PROVIDED
- PLACE AT PLANT LEVEL
- MOUNTED TO AVOID DIRECT RAYS OF SUN

DETERMINING NUMBER AND LOCATION OF THERMOSTATS

- A MINIMUM OF FOUR THERMOSTATS SHOULD BE INSTALLED
- ONE THERMOSTAT SHOULD CONTROL ONE-HALF OF FANS (SET TO OPERATE AT 65°F)
- ONE THERMOSTAT SHOULD CONTROL OTHER HALF (SET TO OPERATE AT 70°F)
- TWO THERMOSTATS CONTROL HEATING SYSTEM (CONNECTED IN SAME MANNER AS THOSE CONNECTED TO FANS)

LIGHT PREFERENCE GROUPS OF PLANTS

MAXIMUM OR HIGHLY INTENSE LIGHT

- 4,000 to 8,000 foot candles for an average length of daylight
- 500 to 2,000 foot candles for survival

INTERMEDIATE LIGHT OR PARTIAL SHADE

- 1,000 to 3,000 foot candles for an average length of daylight
- 100 to 1,000 foot candles for survival

LOW LIGHT INTENSITY OR FULL SHADE

- 50 to 1,000 foot candles for an average length of daylight

METHODS OF REDUCING LIGHT INTENSITY

1. SHADING COMPOUND
2. COTTON CLOTH
3. MUSLIN OR TOBACCO CLOTH
4. SARAN

CVAE AND VEH HORTICULTURE

Unit D: Greenhouse Environment

Topic 2: Watering and Feeding Greenhouse Plants

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Attention is directed to the laboratory exercises at the end of the topic. Also, attention is called to the Useful Conversion Factors and Calculation Shortcuts appearing in the Appendix.

1. Importance of Watering

Two secrets to the success of growing greenhouse plants are proper watering and fertilizing. To make maximum growth, plants must have adequate moisture at all times. Much of the moisture taken in by plant roots is lost through transpiration, evaporation through small openings in the leaves.

A number of factors affect the amount of water needed by plants:

1. Type of container plants are grown in (plants grown in pots normally require more water than bench grown plants.);
2. Temperature
3. Climatic conditions (fair or cloudy) (more water is required on a fair day.);
4. Media (plant roots require an uninterrupted supply of water; however, the water is absorbed very slowly. It is possible for the soil to be saturated with water and the plant not to absorb it because of a lack of oxygen. A media that holds a large amount of water and oxygen is ideal.);
5. Kind of plant;
6. Stage of growth; and
7. Size of plant.

2. Methods of Watering

Several watering devices that may be used to water greenhouse plants are available. A discussion of some of these devices is given below.

Transparency No. 1

A water breaker may be used to water a small number of plants, but it is not recommended for watering all the plants in a greenhouse because of the labor required.

Spaghetti System - This system may be referred to by several different names depending upon the manufacturer. It is particularly good for watering and fertilizing pot plants. A breaker tip is placed in each pot, and the system can be preset to turn itself off after delivering a predetermined amount of water to each pot. The system may be set to operate several times during the day depending upon the needs of the plants.

To determine when to water, the grower may conduct the following tests:

1. If the soil is cool to the touch, the plants probably do not need water.
2. If the soil is dry enough to feel warm to the touch, the plants probably need water.
3. If the insertion and withdrawal of a cane or plastic stick does not have clinging moisture and soil, the plants probably need water. Clinging moisture and media would indicate adequate moisture.
4. Plants showing a slight wilt, called flagging, should be watered.

Flat Spray Nozzle System (Perforated Plastic Tube) - This system is often used to water cut flower crops such as roses, chrysanthemums, carnations, and snapdragons. About one quart of water is applied to each square foot of soil, and one control valve may be used to water from one to six benches. Enough water is applied to moisten all the soil in a bed. If properly watered, the water will drain through the benches or pots.

Mist System - This system is generally used for propagating cuttings and germinating seeds. It consists of a series of nozzles mounted on standpipes at four-foot intervals down the center of the bench. Each nozzle throws a fine mist of water in a flat circular pattern about six feet in diameter.

The water is automatically turned on and off by an electrically operated, short interval time clock. Usually the time clock is set to turn on the water for two seconds in every two minutes, but the interval can be adjusted for a longer time period. The system is operated only during daylight hours (when evaporation is most rapid). It prevents the cuttings from wilting until roots are formed and keeps seed evenly moist until they germinate. A time clock and other equipment needed to install a mist system is shown in transparency No. 3, Topic C-1.

3. Water Quality

Water quality is just as important as quantity of water in the growing of greenhouse plants. Quality of water varies from one location to another, and because of its foreign matter content, some water cannot be used on greenhouse plants.

Water quality should be checked before using it on plants. Strongly alkaline water must be acidified before using on such plants as azaleas, hydrangeas, and gardenias. The chlorine and fluorine added to city water systems for health reasons usually are not in sufficient quantities to have an adverse effect on greenhouse plants. However, it would be a good idea to have the water tested. Some water softeners connected to water systems will add sufficient sodium to cause a serious problem.

4. Feeding Greenhouse Plants

Students must have a knowledge of the various nutrients required by plants and their relationship to the total requirements for plant growth. In the last few years, the methods of applying nutrients to greenhouse plants has changed. The majority of commercial growers are now using a liquid feeding method and are utilizing either single elements or prepared commercial mixtures. The trend toward constant feeding systems seems to consistently produce higher quality plants.

Transparency No. 2

Proportioning pumps are used by most large greenhouse operators. A number are manufactured to operate on water line pressure and do not need any other source of power. The pumps are available in several different sizes and can be set to distribute the amount of soluble nutrients desired.

An inexpensive piece of equipment, called a hozon and discussed in a preceding topic, may be used to apply soluble fertilizer to a small number of plants. Standard hozon nozzles are calibrated at 1:15, one gallon of fertilizer to 15 gallons of water.

The following formula may be used to determine the amount of concentrate solution to use with a hozon or proportioner with a known ratio. This is based on pounds of fertilizer per gallons of water.

p = known rate of proportioner (gallons)
q = concentrate solution desired (gallons)
r = rate of application (gallons of solution)
s = rate of application (pounds or weight of dry fertilizer)
t = amount, by weight, of fertilizer to place in concentrate solution

$$\frac{p \times q}{r} \times s = t$$

Example: (a) Proportioner 1:100
(b) 10 gallons of concentrate
(c) 1 oz. Ca NO_3 per 2 gallons H_2O

$$\frac{100 \times 10}{2} \times 1 \text{ oz.} = 500 \text{ oz. or } 31\tfrac{1}{4} \text{ lbs. } CaNO_3 \text{ in 10 gal. concentrate}$$

Example: (a) Proportioner 1:34
(b) 5 gallons concentrate
(c) 3 pounds per 50 gallons

$$\frac{34 \times 5}{50} \times 3 \text{ lbs.} = 10.2 \text{ pounds in 5 gallons of concentrate}$$

Note: To arrive at rate per gallon: t/pq always equals rate per gallon.

LABORATORY EXERCISE NO. 1

Activity:

Determine the amount of fertilizer to use in a desired amount of concentrate solution in a proportioner with a ratio of 1:200. Twenty gallons of concentrate are to be mixed, and $CaNO_3$ will be mixed at the rate of 1 ounce to 1 gallon of water.

Materials:

Pencil and paper

Procedure:

Formula at top of page is used to determine answer.

LABORATORY EXERCISE NO. 2

Activity:

Determine the amount of 20-20-20 analysis liquid fertilizer that should be placed in 1 gallon of water in order to apply the mixture at the rate of 1 ounce to 2 gallons. (The Useful Conversion Factors and Calculation Short-Cuts in Appendix are used.)

Materials:

Pencil and paper

Procedure:

This simple problem can usually be worked by students without using pencil and paper; however, the following formula may also be used:

$$\frac{\text{ounces}}{\text{gallons}} = \text{amount per gallon}$$

LABORATORY EXERCISE NO. 3

Activity:

Determine the amount of ammonium nitrate that should be placed in a 100-gallon container to obtain 200 ppm.

Materials:

Pencil and paper
Conversion chart given in Appendix

Procedure:

1. All students should understand what is meant by parts per million. Examples of one part per million are 1 crystal of salt in 5 pounds, 1 drop in 16 gallons, 1 inch in 158 miles, 1 minute in 1.9 years, 1 pound in 500 tons, and 1 cent in $10,000.

2. The formula given in the conversion chart in the Appendix is not mathematically accurate, but it is accurate enough for the ratios normally used in fertilizer solutions. The error will be 0.02 or less. The following formula is used:

   % of element in fertilizer x 75 = ppm of 1 oz. of fertilizer in 100 gal. of water
   Ammonium nitrate = 33% nitrogen
   0.33 x 75 = 24.75 ppm obtained from 1 oz. ammonium nitrate in 100 gal. water

3. The following formula is used to determine the number of ounces required for a 200 ppm solution.

   200/24.75 = 8.08 or 8.1 ounces

LABORATORY EXERCISE NO. 4

Activity:
Determine the accuracy of the calibration of a hozon nozzle

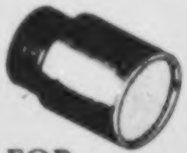
Materials:
Hozon nozzle
Container that will hold one gallon of water
Containers of known capacity

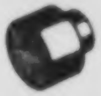
Procedure:

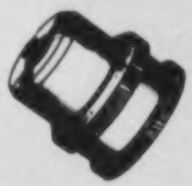
1. The siphon tube is placed in the container holding one gallon of water.
2. The number of times the containers of known capacity are filled by the time one gallon of water is exhausted are counted.
3. The calibration is calculated.

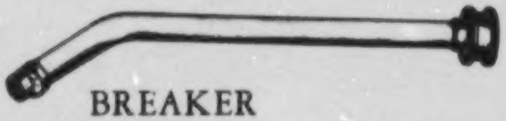
WATERING DEVICES

WATER BREAKERS

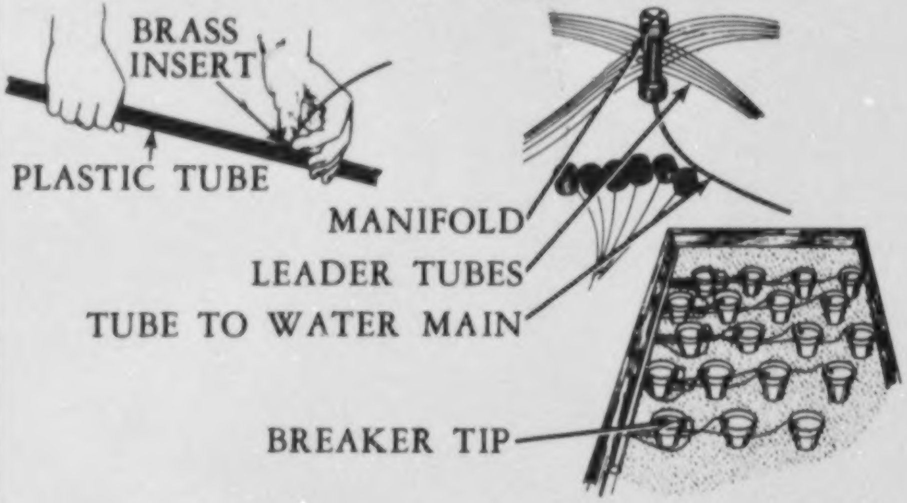

FOR
POT PLANTS
7.5 g.p.m.


GENERAL
WATERING
10.9 g.p.m.

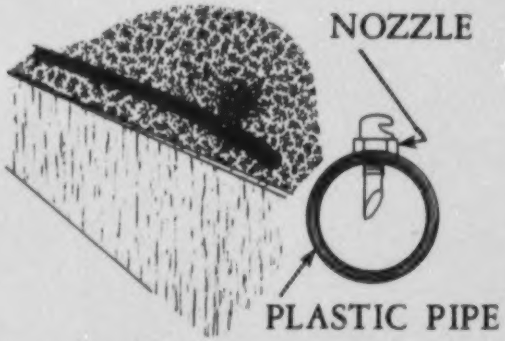

WATER SPRAY
.75 g.p.m.


BREAKER
EXTENSION HANDLE

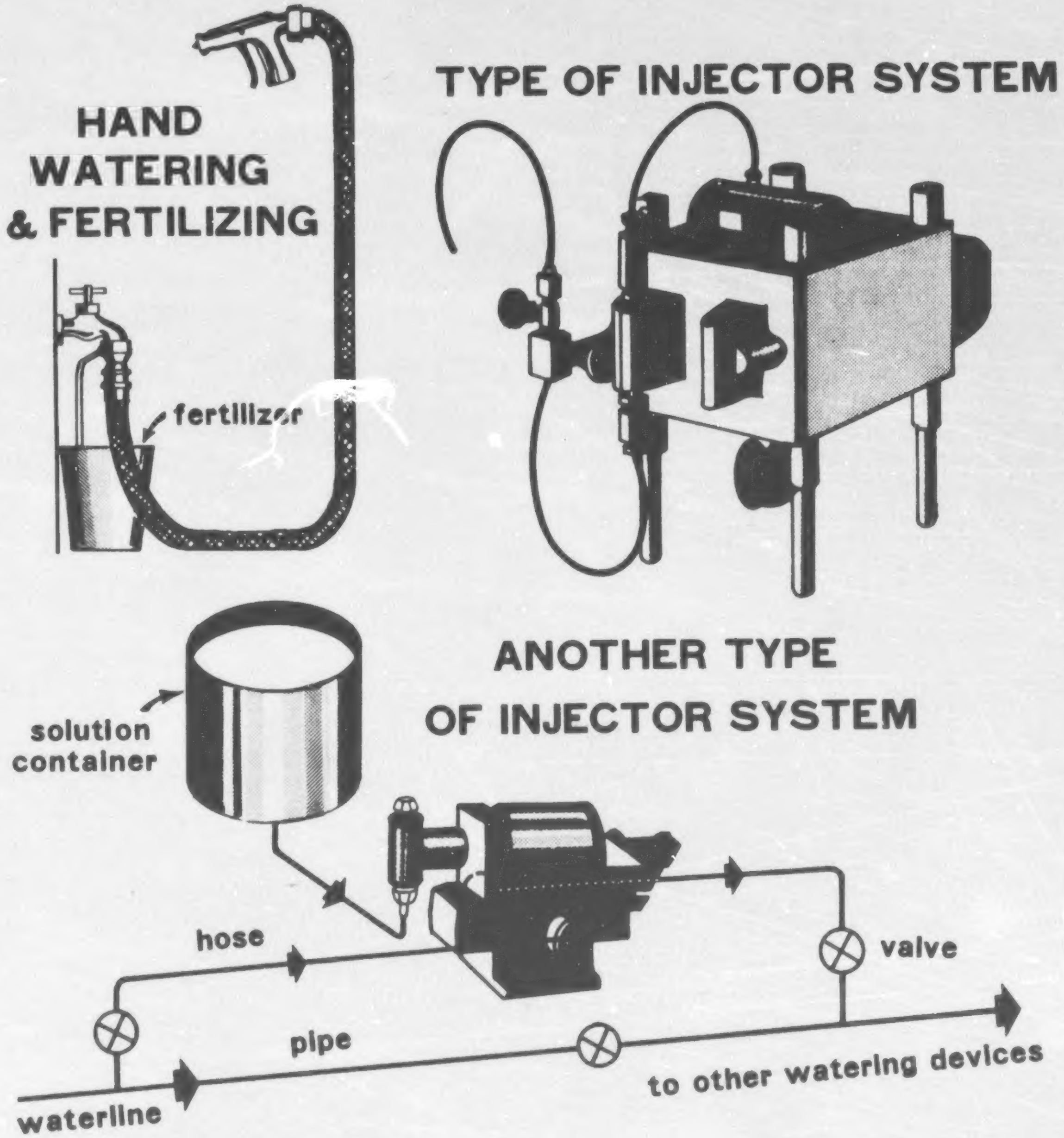
SPAGHETTI SYSTEM


BRASS
INSERT
PLASTIC TUBE
MANIFOLD
LEADER TUBES
TUBE TO WATER MAIN
BREAKER TIP

FLAT SPRAY NOZZLE SYSTEM


NOZZLE
PLASTIC PIPE

WATERING & FERTILIZING EQUIPMENT



HAND WATERING & FERTILIZING

TYPE OF INJECTOR SYSTEM

ANOTHER TYPE OF INJECTOR SYSTEM

fertilizer
solution container
hose
valve
pipe
waterline
to other watering devices

CVAE AND VEH HORTICULTURE

Unit E: Soils and Plant Growth and Development

Topic 1: Propagation Media

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

After discussing the topic in class, it is suggested that a demonstration be given on the proper mixing of propagation media. The procedure to follow is given in the laboratory exercise at the end of the topic.

1. Soil Characteristics

Soils have certain characteristics which distinguish them from each other. One of the most important physical features of the soil is the size of soil or mineral particles. This is referred to as soil texture. Based on texture, soil may be classified into several groups; but the three most important soil groups to the greenhouse operator are clay, loam, and sand.

Transparency No. 1

Clay soils have the finest particles (texture). One pound (four-inch pot of clay) has approximately 45,500 square yards of surface area. Because of its enormous surface area, clay can hold more moisture than soils of the other groups. However, clay particles because of their size are easily compacted and will not allow the entry of oxygen. In order for plants to absorb moisture, oxygen must be present in large quantities.

There are many kinds of loams. They are mixtures of clay, silt, and sand, and the texture depends upon the mixture or content of each. Loams may or may not have the capacity to hold large quantities of moisture and oxygen.

Sands are classified as fine, medium, and coarse; but the particles of fine sand are much larger than clay particles. Sand will not hold as much moisture as clay and loam, but it readily allows the entry of oxygen. Sand weighs 100 pounds per square foot and is the heaviest soil used in media mixtures. It contains very little nutrients.

Soil structure is another characterisitic of soils. Structure is the arrangement of soil particles and is determined by the amount of organic matter and clay in a soil. A soil with a good structure crumbles easily and will not compact.

Another soil characteristic is composition. This refers to the organic and mineral content of the soil. The soil composition can change rapidly. Some soils have a tendency to break down and lose their organic and mineral matter.

Although soils have other characteristics, a knowledge of those discussed will assist students in determining the quality of the propagation media mixtures.

2. Media Materials

A discussion of the several kinds of materials that may be used in propagation media mixtures is as follows:

Peat Moss - It is the remains of an aquatic bog, marsh, or swamp vegetation preserved under water in a partially decomposed state. Peat will vary according to vegetative origin, state of decomposition, mineral content, and acidity.

Sphagnum Peat Moss - Sphagnum peat is the dehydrated remains from stems and leaves of several species of sphagnum mosses. It is very light in weight, absorbs 10 to 20 times its weight in water, contains 95% to 99% pure organic matter, has a pH reaction of 3.0 to 4.5, contains 1-1/2% nitrogen, and is relatively sterile.

Vermiculite - It is developed by running magnesium or aluminum iron sulfate through a furnace at 2,000° F. This causes it to form small, porous, sponge-like particles. Vermiculite is light in weight (6 to 10 lbs. per cubic foot), has a neutral pH, is insoluble in water, absorbs 3 to 4 gallons of water per cubic foot, breaks very easily when wet (causing it to lose its effectiveness), has the capacity to hold nutrients and gradually release them, and provides the magnesium and potassium needs of most plants.

Perlite - It originated from a lava flow. It is processed by crushing, screening, and running through a furnace at 1,800° F. The heat causes the particles to expand and become sponge-like. It is light-weight (6 to 8 lbs. per cubic foot), holds 3 to 4 times its weight in water, has a neutral pH reaction, will not hold nutrients, and is sterile.

Leaf Mold - Most any kind of tree leaves may be used in compost for making leaf mold. Leaf mold is prepared by making a compost of leaves and soil. Compost is made by covering a layer of leaves with a thin layer of soil and adding a nitrogen compound such as sulfate of ammonia. Several alternate layers of leaves and soil may be placed on top of each other. The compost should be watered often enough to maintain decomposition action and should be protected from the weather to prevent leaching. From twelve to eighteen months are required to prepare the leaf mold. Since it is possible that leaf mold will contain weed seeds and disease organisms, it should be sterilized before using.

Bark, Sawdust, and Wood Shavings - These are by-products of the lumber industry and may be used to replace peat; however, they decompose at a much slower rate.

Shredded pine bark is available in most areas. It will absorb nutrients and release them slowly, is free of weed seeds and insects, has a nitrogen content of .2% to .4%, has a pH reaction of 3.5 to 3.7, and is slow to decompose.

Soil Amendment - Calcined clay is one of the most often used soil amendments. It resists decomposition; mixes well with peat, soil, and other media; and weighs about 36 lbs. per cubic foot. Turface and Terra-Green are trade names of this product.

3. Media Mixture Properties

Regardless of the mixture used, the media must have certain properties in order for the plants to grow properly. Some are listed below:

Transparency No. 2

1. The media must be firm and dense enough to hold seeds and cuttings in place;
2. Its volume should be fairly constant whether the media is dry or wet;
3. It must retain enough moisture to prevent too frequent watering;
4. It must be porous enough to permit aeration and drainage of excessive water;
5. It must be free of weed seeds and disease organisms; and
6. It must have a pH level suitable for the plants to be grown.

4. Recommended Media Mixtures

One particular media mixture for propagating plants cannot be recommended for all situations.

The following mixture may be used for both propagating by seeds and growing seedlings. It is an ideal mixture when automatic watering and feeding systems are used and is recommended by the Horticulture Department, Texas A&M University. The ingredients listed will make one cubic yard of mixture.

13.5 cu. ft. horticulture grade perlite
13.5 cu. ft. sphagnum peat moss
7 lbs. 20% superphosphate
1-3/4 lbs. dolomite (a natural mineral, pulverized limestone)
7 lbs. fertilizer (8-12-4 analysis)
1-3/4 oz. chelated iron
7 lbs. gypsum

The basic ingredients in the above mixture are perlite and sphagnum peat moss. Since these two materials contain very little nutrients, the other slowly available nutrient materials are added.

The following mixture is recommended by the University of California and may be used when propagating plants from seeds or cuttings. Nutrients are supplied by an automatic watering and feeding system or other means.

(1) 50% fine sand (sterile)
(2) 50% peat moss

The following items should be added to the above mixture if it is going to be used within one week:

4 oz. horn and hoof or blood meal (13%N)
4 oz. potassium sulfate
2-1/2 lbs. mono-superphospate
7-1/2 lbs. dolomite lime
2-1/2 lbs. calcium carbonate lime

If the mixture is going to be stored for an extended period of time, it is recommended that the horn and hoof or blood meal be deleted.

When preparing the mixture, the grower should see that the ingredients are measured accurately and mixed throughly.

LABORATORY EXERCISE

Acitivity:
Demonstration of the proper mixing of a growing media

Materials:
The materials needed will be determined by the media mixture used. All items to be included in the mixture should be available in the quantities needed.

Procedure:

1. In order that the ingredients used in smaller quantities will be uniformly distributed throughout the media, they should be mixed first. Using the mixture recommended by Texas A&M University as an example, the 1-3/4 oz. of chelated iron should be thoroughly mixed first. Then, this should be mixed with one of the materials used in a larger quantity. It could be mixed with the 7.0 lbs. of 20% super-phosphate. Mixing these as suggested will give the materials used in smaller amounts enough volume so that they can be mixed uniformly throughout the mixture. Small amounts of media can be easily mixed in a cement mixer.
2. It is almost impossible to mix dry peat moss uniformly with other materials. When mixed while dry, some of the peat will remain in lumps and will withdraw moisture from the rest of the mixture. If peat moss is going to be used in the mixture, it should be prepared as suggested. Spread it out in a thin layer on the floor or on a mixing table. Water the peat thoroughly and break all the lumps. The application of a commercial wetting agent will help in applying water uniformly to the peat. Follow directions given by manufacturer.
3. The peat and other ingredients, excluding the fertilizer elements and soil additives, are mixed. This is accomplished by placing alternate shovels of ingredients that will compose the mix into a pile.
4. The mixture is blended again by tossing the mixture from first blending pile to another pile.
5. The mixture is spread evenly on the floor or mixing table, and the fertilizer

and additives to be included in the mixture are spread evenly on top of the blended mix. All of the ingredients to be used in the mixture are now blended by tossing over into a new pile a shovel full at a time.

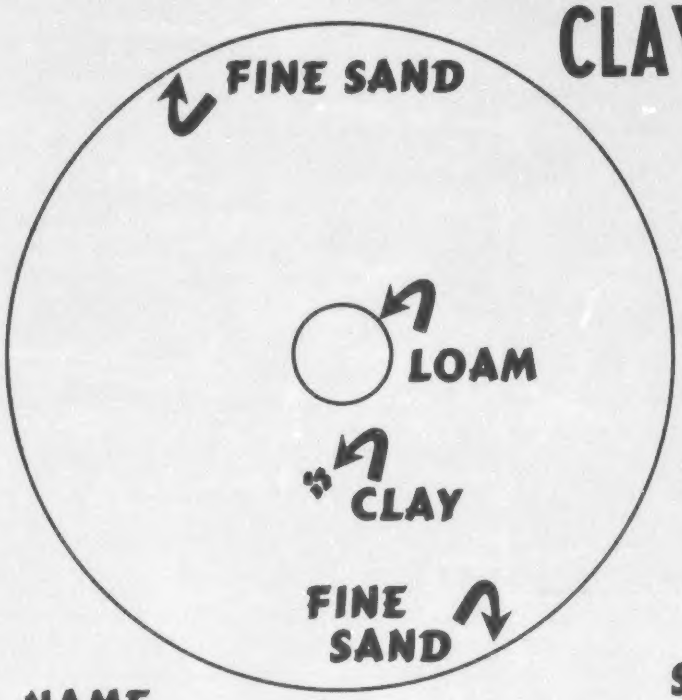
6. The blending process should be repeated if mixture is not uniform.

References:

1. Hartmann, Hudson Tom, and Dale E. Kester, Plant Propagation Prinicipiles and Practices, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968.

2. Bailey, Leo L., A Step-By-Step Guide to Landscaping and Gardening, Exposition Press, Hicksville, New York, 1974.

RELATIVE SIZES OF SAND, SILT, & CLAY PARTICLES


FINE SAND
LOAM
CLAY
FINE SAND

SIZE OF SOIL PARTICLES

NAME	**SIZE, DIAMETER IN MILLIMETERS**
coarse sand	1.00-0.50
medium sand	0.50-0.25
fine sand	0.25-0.10
very fine sand	0.10-0.05
loam	*varies*
clay	*less than* 0.002

A PROPAGATION MEDIA SHOULD POSSESS THESE PROPERTIES

1. SUFFICIENTLY FIRM AND DENSE
2. VOLUME CONSTANT
3. RETENTIVE OF MOISTURE
4. POROUS
5. FREE OF WEED SEEDS & DISEASE ORGANISMS
6. SUITABLE pH

Vocational Instructional Services	
Agricultural Education

E-2
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit E: Soils and Plant Growth and Development

Topic 2: Nursery Soils

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Two laboratory exercises are provided at the end of this topic. One exercise determines the permeability of the three kinds of soil, while the other determines the acidity or alkalinity of a soil sample.

1. Soil Origin and Formation

Millions of years ago the earth was solid rock. Weathering caused by snow, ice, wind, and rain gradually broke the rock into soil particles. As the snow and ice melted, the water dissolved some of the particles and washed them down to the lower-lying areas. Small plants began to grow and hastened the soil forming process. This was the beginning of some of the soil formations that we have today.

Soils are different in color because they were formed from different kinds of soil deposits. A brief listing of the different kinds of soil deposits and an explanation of how they were formed is given below:

Residual soils, our oldest soils, were formed in place and developed from the rocks upon which they rest.

Ice deposits, according to geologists, were formed four times during our geologic history. The climate became so cold that a huge sheet of ice, one mile thick in places, moved south from Canada and covered the United States. As the ice moved southward, it ground the rocks beneath, gouged the valleys, scoured the loose materials off the hills, and mixed them together. This mixture, called glacial till, contained fine particles, stones, and sometime huge boulders. The formation of these soils took place over a period of hundreds of years. Unlike residual soils, the glacial till does not contain the underlying rocks.

Glacial stream deposits formed soils as the world warmed. The glaciers melted, and the running water produced rivers which carried and deposited gravel, sand, and clay into the valleys and along sides of streams.

Lake deposits were also formed by glaciers which dammed valleys, streams, and rivers and created artificial lakes. As the ice melted, water running into these lakes carried soil into them; and the soil settled to the bottom. Soil deposits were left when the glacier ice dams melted and the lakes were drained. After the glacial period, soil profiles (defined and explained later in topic) were much the same from top to bottom. However, as plants began to grow and die, topsoil was formed; the decomposed plants and animals gave the topsoils their dark color.

2. Soil Development

Soils have developed from the simultaneous action of parent materials, weathering, climate, native vegetation and organisms, and drainage on slopes. These five factors are responsible for the characteristics of soils and are interrelated. Each is discussed briefly.

Parent Material - This is the unconsolidated mass of materials from which soil is formed.

It is the "C" layer of the profile which is located over the earth's bedrock. It is composed of rocks, other minerals, and sometimes peat. Parent material is deposited as either residue or transported soils.

The kinds of parent material from which a soil is formed influence many characteristics of the soil. Texture and natural fertility are two of the characteristics influenced by parent material.

Weathering - The two major processes involved in the weathering of soil are chemical and physical. Chemical weathering is the result of the chemical reactions of water, oxygen, carbon dioxide, and other substances that act upon soil materials. Physical weathering refers to mechanical forces caused by temperature changes such as heating, cooling, freezing, and thawing. As the chemical and physical processes occur, soil forming materials are broken into smaller and smaller particles until soil is made.

Climate - Temperature and rainfall greatly affect the rate of weathering. When the temperature rises, the rate of chemical reaction increases; and growth of fungi, soil bacteria, and plants increases.

Native Vegetation and Organisms - Vegetation and organisms exert considerable influence upon the formation of soil. Soil bacteria and fungi aid in soil formation by causing the decay and breakdown of plant and animal residue in the soil. These processes cause the release of carbon dioxide and other compounds essential for the formation of soils.

Slope and Drainage - These affect soil formation both directly and indirectly. On a steep slope, for example, the effect is direct; loose materials are moved downward by runoff water and gravity. The movement not only breaks up soil materials and adds them to the lower levels, but exposes subsoil materials along the upper slopes.

Slope affects the distribution of water that falls on the earth's surface. Runoff on steeper slopes reduces the amount of percolation of water (downward and upward movement) through the soil. Slope and drainage also affect the soil in other ways.

3. Components of the Soil

Soils are made of living and non-living materials which are in three forms: solids liquids, and gases. The solids are the organic matter and minerals found in the soil, while the air and water in the soil are the gases and liquids.

Transparency No. 1

Approximately 45 to 49 percent of the soil (by volume) is mineral; one to five percent is organic matter; and 50 percent is water and air.

The mineral in the soil is inorganic and contains approximately 64 elements, which should be available to the growing plants. Some of the elements are of minor importance, but 14 are considered to be of major importance. Nitgrogen, phosphorus, and potassium are three of the 14 more important elements. Soil elements, with the exception of those introduced by man, come from rocks and decayed plants and animals. The amount of organic matter, formed from decomposed plants and animals, affect the soil tilth, a physical feature.

4. Soil Profile

A soil profile consists of two or more layers of soil lying one below the other and parallel to the land surface. The layers are known as horizons, and they differ in one or more properties such as color, texture, structure, consistency, porosity, and reaction.

Transparency No. 2

The A horizon, called surface soil, lies above the B horizon. The B horizon is the subsoil. The C horizon, consisting of the upper part of the loose and partly decayed rock material, is beneath the B horizon and is called parent material.

Soil horizons vary in thickness and generally are merged with one another; therefore, the horizons usually lack sharp boundaries. Most soil profiles include three master horizons which are identified by the letters A, B, and C; however, some soils lack a B horizon and are said to have an AC profile. Eroded soils may not have an A horizon, and in some cases the B horizon may have eroded away.

The combined A and B horizons are the major part of a profile and is called the solum or true soil. This is the area that supports plant growth.

5. Soil Texture and Permeability

As stated in Topic E-1, soil texture refers to the size of the individual soil particles and is thought of as the fineness or coarseness of soil particles. Most soils are a mixture of sand, silt, and clay. It would be unusual for a soil to be made up of only one kind of soil particle. The soil texture is determined by the percent of sand, silt, and clay in the surface layer.

Transparency No. 3

Each soil particle has a distinctive feel. A horticulturist should be able to determine the texture of the soil by feeling of it. The soil should be moist when determining texture.

To determine texture by feeling, a small amount of soil is placed in the hand and worked between the thumb and index finger.

A clay soil will form a ribbon an inch long and one-eighth of an inch thick. A silt or loam soil will only form about one-half inch ribbon or no ribbon at all, while a coarse-textured soil will not form a ribbon. Another method of identifying a coarse-textured soil is to mold a column of soil about the same diameter as a half-dollar. If the molded column will not hold horizontally, it is coarse.

Soil permability, the rate water and air enter the soil, is closely related to soil texture. The finer the texture of the soil, the slower water and air enter it. Also the finer the soil particles, the more water the soil will hold.

During the weathering process, there is a tendency in permeable soils for fine clay particles to move downward from the surface into the subsoil. This movement, together with further breakdown of rock materials, accounts for the fact that many soil types have a higher percentage of clay in the subsoil than in the surface soil.

6. Soil Structure

Soil structure is the term used to describe the arrangement of soil particles that appear in various sizes and shapes. The soil structure is important because soils having different structures are managed differently.

Soils having a good tilth (structure) contain a lot of aggregates. This permits deeper root penetration and a larger area from which plants can secure nutrients. Differences in soil structures can readily be observed when taking and comparing a sample taken from a field continuously cultivated and one from an area with a dense, heavy growth of grass. The sample taken from the grassy area will be grainy and will contain a large amount of aggregate, while the sample taken from the field will be firm, hard, and lack aggregates.

Transparency No. 4

Soil scientists have named the shape of each kind of structure in which the particles arrange themselves differently. The eight common types of soil structures are granular, crumb (similar to granular), platy, prismatic, columnar, blocky, single grain, and massive.

Soil particles are grouped into aggregates by the action of complex sugars. While one part of the sugar arranges the soil particles loosely into clusters, another part is binding the particles firmly into aggregates. Before soil particles can be bound into aggregates, they must be grouped into loose clusters.

Flocculation, the first step in forming a soil aggregate, is caused by nature. Flocculation pulls the clay particles close together so that they are cemented with gum, made from soil sugars. The second step in aggregate formation is the binding of clay particles in the flocs into aggregates.

The removal of plant cover from the soil destroys aggregation and the sugars that bind the particles. The longer the soil is without a cover, the more break down there is in the aggregate. As plants grow and cover the soil, aggregates start to rebuild and stop the break down.

7. Soil Acidity and Alkalinity

Acidity and alkalinity are important factors which influence plant growth in a number of ways. The amount of acidity or alkalinity in the soil is referred to as soil reaction. The soil reaction is indicated on a pH scale developed by chemists. The scale is divided into 14 equal parts (0-14) similar to a ruler. A reading of zero on the scale is the maximum amount of acidity, and the maximum alkalinity is 14.

Transparency No. 5

A pH of seven is considered to be neutral and has equal amounts of acid and alkaline elements. Soils with a pH of 7 to 14 are referred to as being sweet or basic; soils with pH of 0 to 7 are said to be sour.

Each whole number on the pH scale is ten times greater than the next whole number. For example, a soil that has a pH of five is ten times more acid than a soil with a pH of six. A pH of four is 100 times more acid than a pH of six.

All of the ways in which the soil pH affects growing plants is not completely understood, but the following are known facts. Many plants grow faster and produce more in a slightly acid soil, because of the availability of plant food elements in slightly acid soils.

Transparency No. 6

Plant food is more readily available when the pH is 5.5 to 8.5. The more acid or alkaline soils may have just as large a volume of plant food elements, but the acidity or alkalinity prevents it from being available to plants. The pH requirements for most crops is between 6.4 and 7.4. A soil pH of 4.5 or lower is too acid, and a soil pH of 8.5 or more is too alkaline. The recommended pH for various fruits, shrubs, and trees is given in the following transparency.

Transparency No. 7

The acid condition of soil can, to a certain extent, be temporarily remedied; and an acid condition is easier to neutralize because of the availability and price of soil amendments used for this purpose. Amendments that may be used are ground limestone and hydrated lime; however, hydrated lime should be used only when a rapid change in the soil pH is desired and when the soil can be saturated with water after its application. The rate of amendment application should be based upon a soil test.

Soils may become alkaline by slowly being made alkaline or naturally being alkaline. Natural alkaline soils are formed from parent material rich in calcium. Irrigating soils with water that contains a large amount of calcium may cause the soil to slowly become alkaline. One would expect to find alkaline soils in areas of low rainfall because the calcium has not been leached from the soil. The greatest effect that alkaline soils have on plants is the limited plant food available. Nitrogen and phosphorus particularly are limited.

There is not an economical method of reducing the alkalinity of the soil. Iron sulfate and sulphur may be used to lower the soil pH, but a large application on a relatively small area is required. Often the application of the recommended rate of either sulphur or iron sulfate causes a toxicity problem. The soil reaction to iron sulfate is fast, while the reaction to sulphur is slow.

LABORATORY EXERCISE

Acivity No. 1: Soil permeability

The purpose of this exercise is to demonstrate the effects of soil permeability using different textures of soil.

Materials:

Sample of sandy soil

Sample of loamy soil

Sample of a clay soil

Three lamp chimneys or three quart cans with holes punched in them

Three pieces of window screen or three pieces of cheesecloth

Three quart jars to hold water

Three measuring cups or jars to hold water

Procedure:
1. The soil is lightly placed in the lamp chimneys which have one end closed with the screen wire or cheesecloth or the cans. Each container is filled to the same level.
2. The measuring jars are filled with water. Each should contain the same amount of water.
3. The lamp chimneys or cans are placed over the collecting jars, and an equal amount of water is poured in each container.
4. The time required before each sample starts to drip should be recorded.
5. Measure and record the amount of water that has gone through the samples at a specific time.

The students should be able to determine the sample with the slowest permeability and the fastest permeability. The students should also observe the bubbles of air rising through the soil as the water replaces the air in the soil.

Acivity No. 2: Litmus Paper Test for Acidity and Alkalinity

Materials:

Soil samples (coarse soil and fine soil)

Test tube for each sample

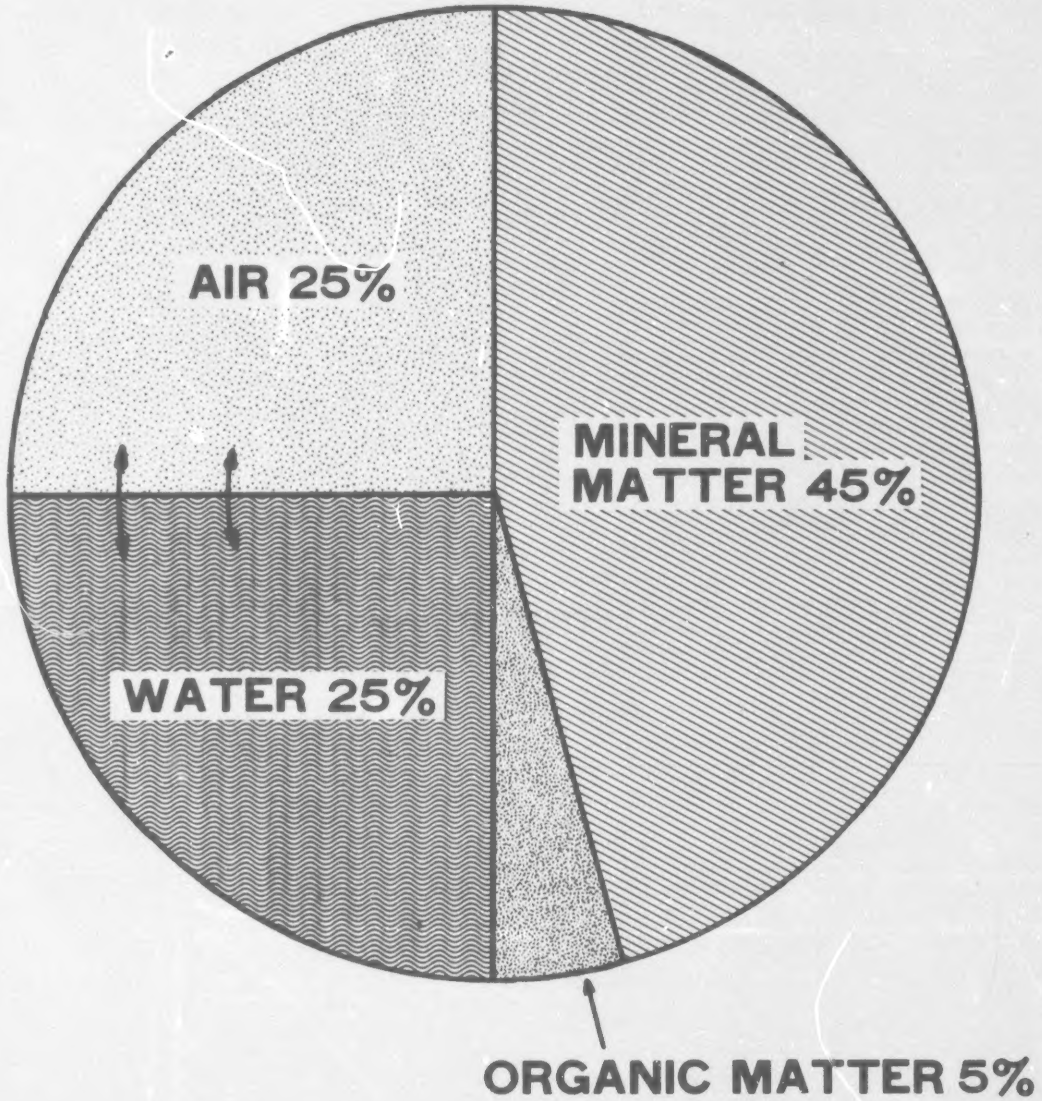
Distilled water

Litmus paper or pH reagents

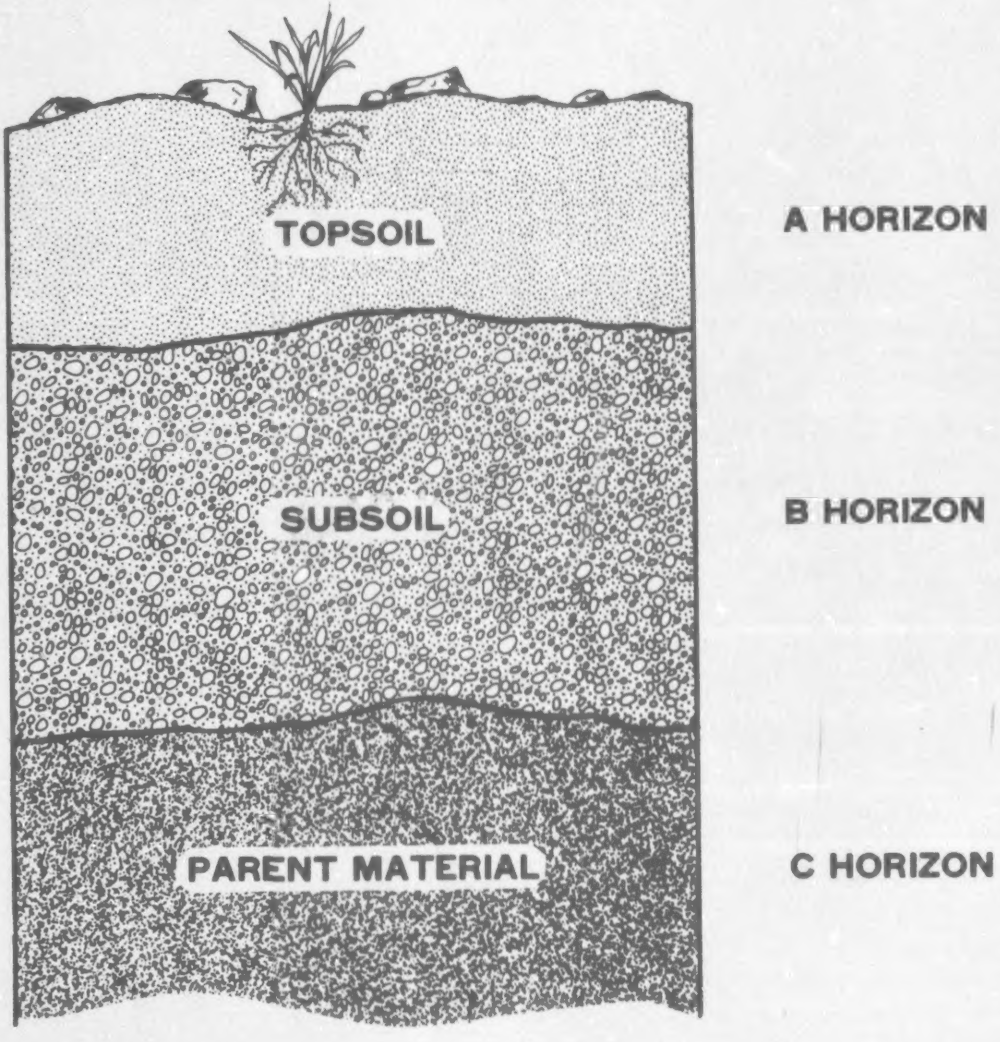
Procedure:
1. One inch of soil is placed in the test tube and mixed with some of the distilled water.
2. The solution is allowed to settle.
3. One end of a strip of litmus paper is placed in contact with the soil solution.

If the litmus paper turns red, the solution is acid; and if it turns blue, the solution is alkaline. This test is not accurate, but it does show the difference in soil pH.

COMPOSITION OF AVERAGE SOIL

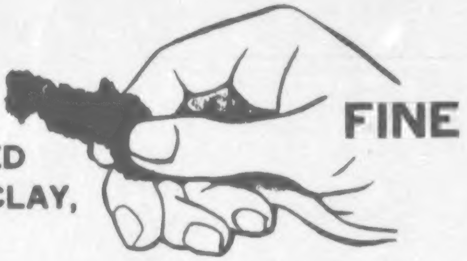


LAYERS IN A SOIL PROFILE

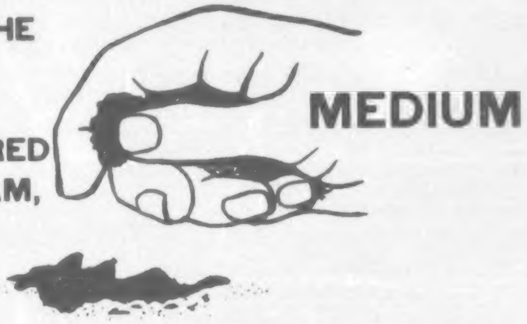

TOPSOIL
A HORIZON
SUBSOIL
B HORIZON
PARENT MATERIAL
C HORIZON

HOW TO DETERMINE SOIL TEXTURE

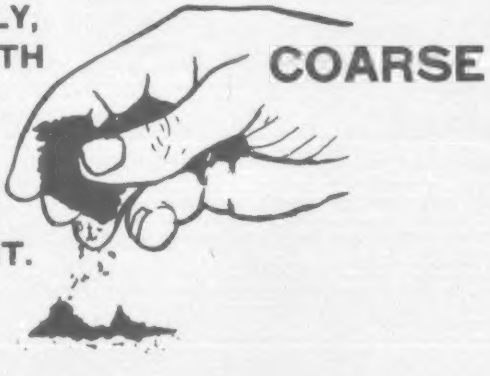
IF YOU CAN FORM A LONG PLIABLE RIBBON FROM A BALL OF MOISTENED SOIL, THE SOIL IS FINE TEXTURED AND MAY BE CLAY, SILTY CLAY, OR SANDY CLAY.



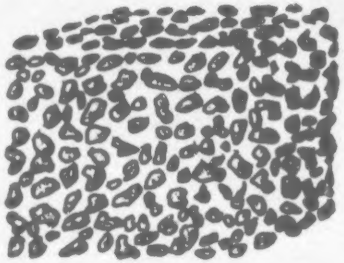
IF NO RIBBON FORMS. AND THE SOIL FEELS SMOOTH WITH SLIGHT OR NO GRITTINESS, THE SOIL IS MEDIUM TEXTURED AND MAY BE LOAM, SILT LOAM, OR SILT.

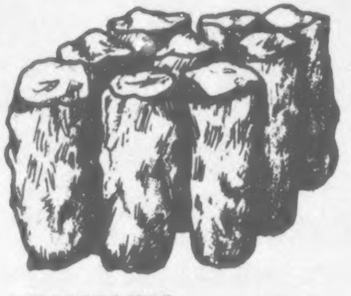


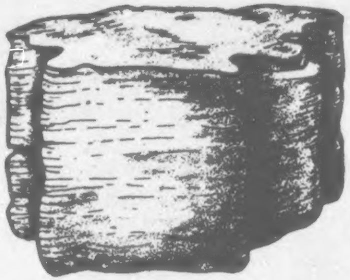
IF THE SOIL CRUMBLES EASILY, FEELS MARKEDLY GRITTY WITH A LACK OF SMOOTHNESS, IT IS COARSE TEXTURED AND MAY BE SANDY LOAM OR LOAMY SAND DEPENDING ON HOW MUCH SAND IS PRESENT.

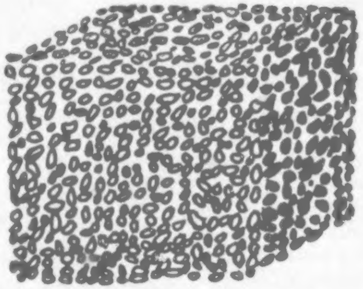


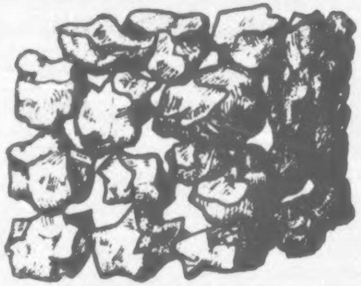
SOIL STRUCTURE

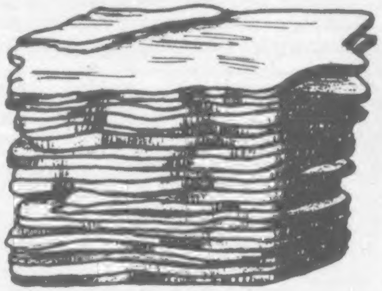

GRANULAR


PRISMATIC

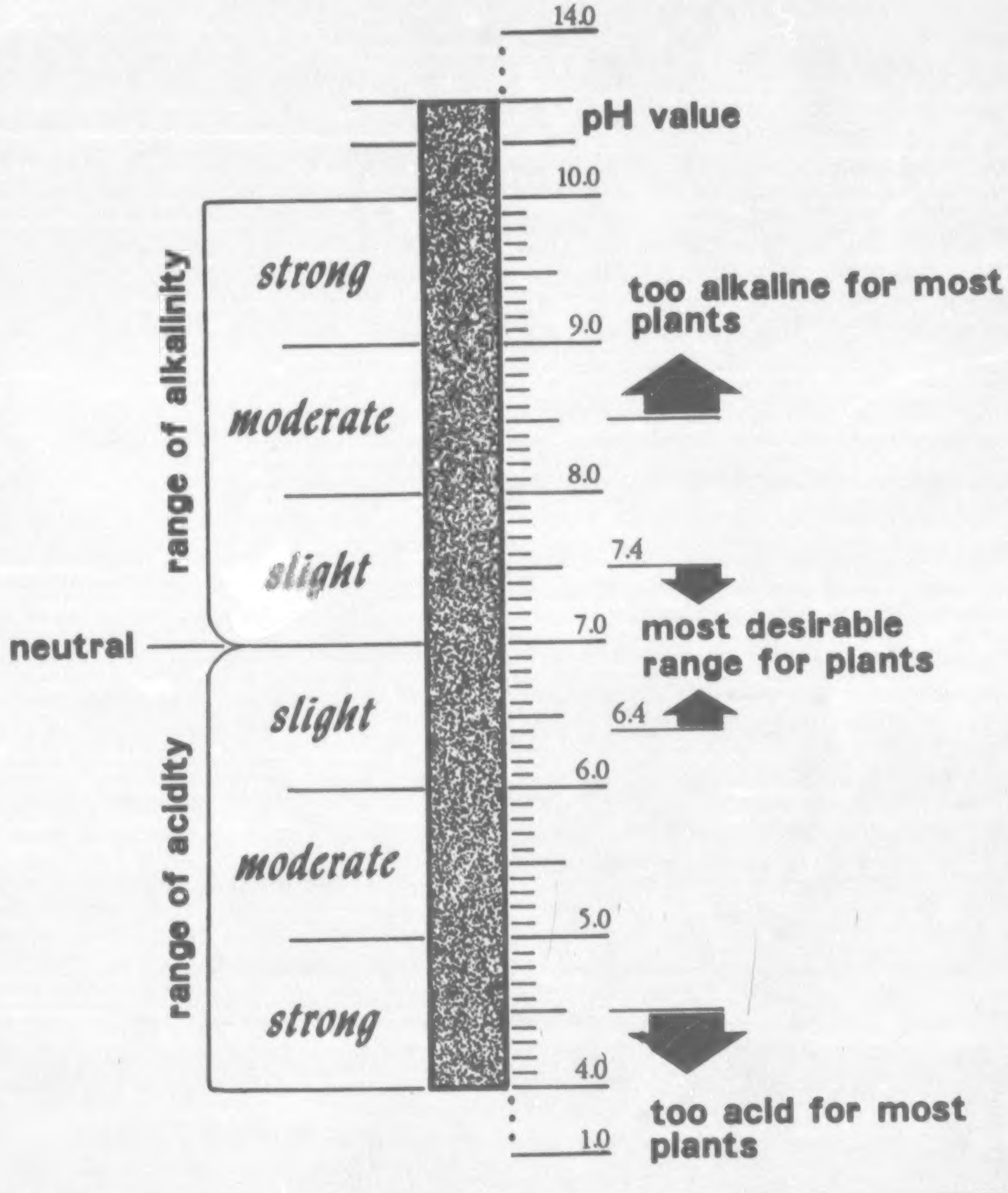

MASSIVE


SINGLE GRAIN


BLOCKY

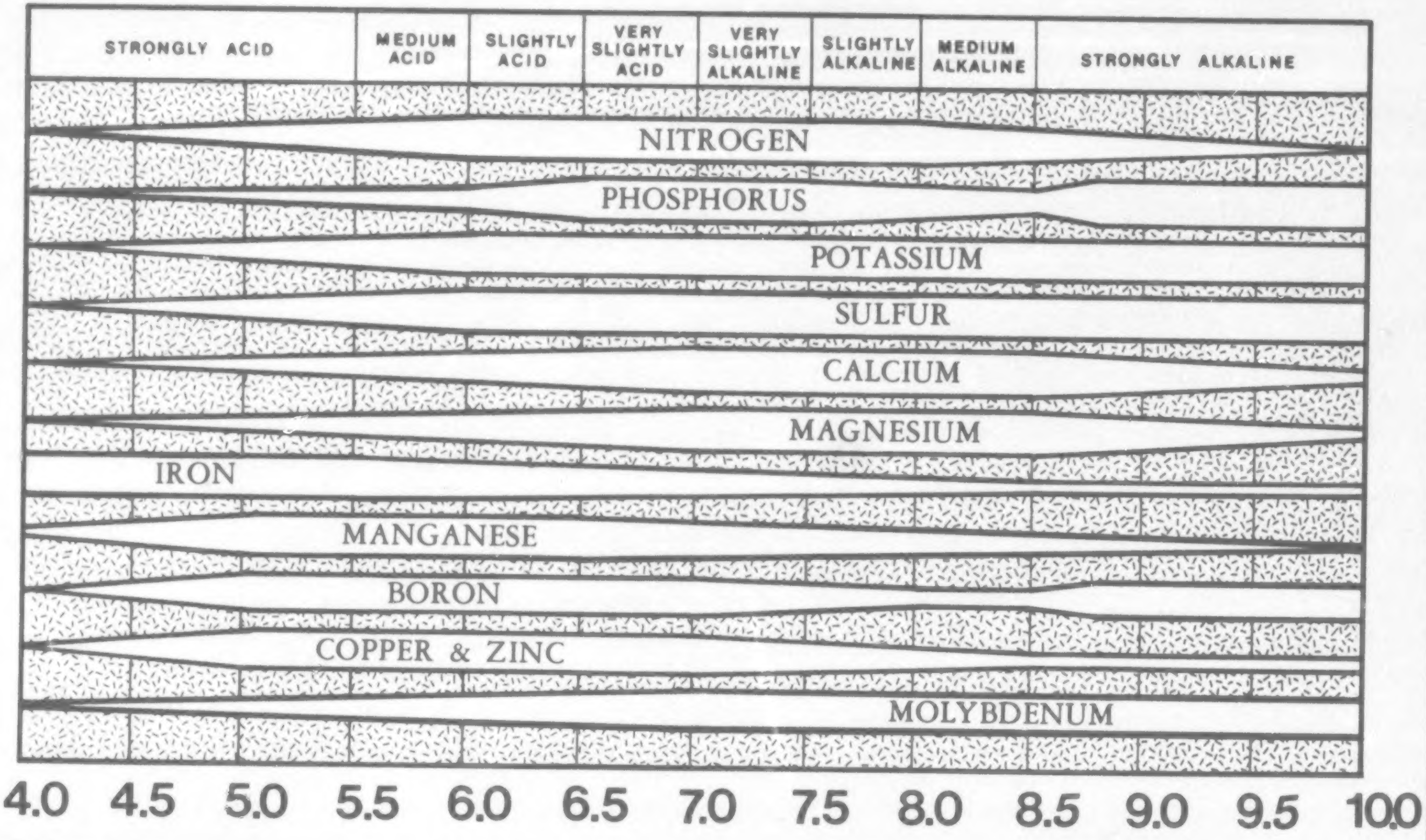

PLATY

pH SCALE

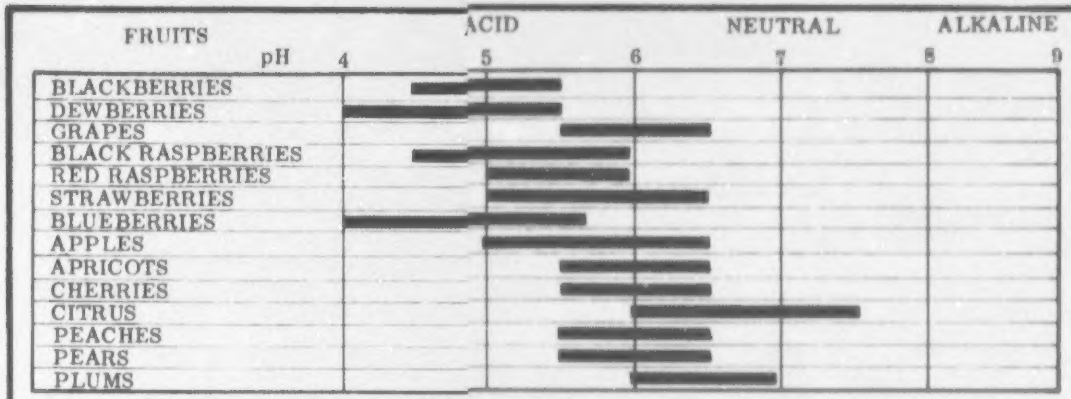

14.0
pH value
10.0
range of alkalinity
strong
moderate
slight
9.0
too alkaline for most plants
8.0
7.4
neutral
7.0
most desirable range for plants
6.4
range of acidity
slight
moderate
strong
6.0
5.0
4.0
too acid for most plants
1.0

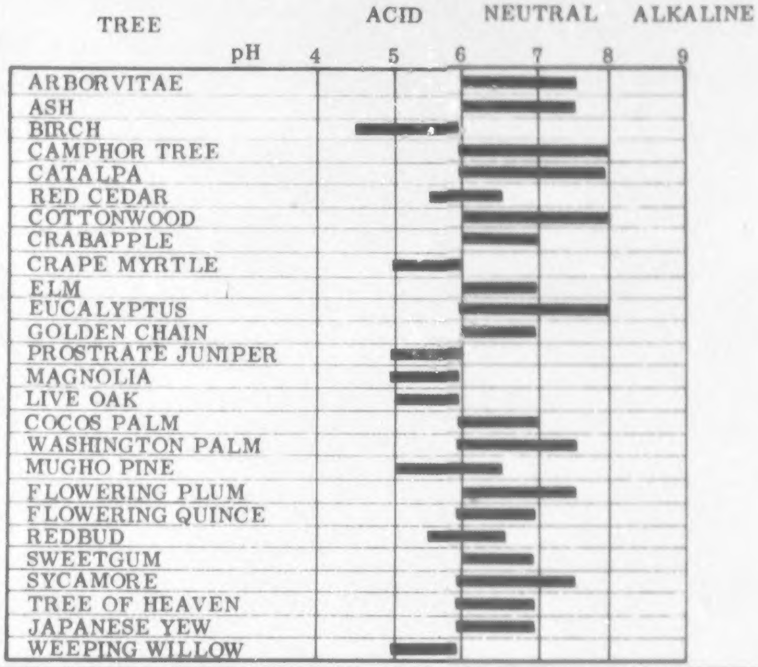
SOIL pH AFFECTS AVAILABILITY OF PLANT NUTRIENTS

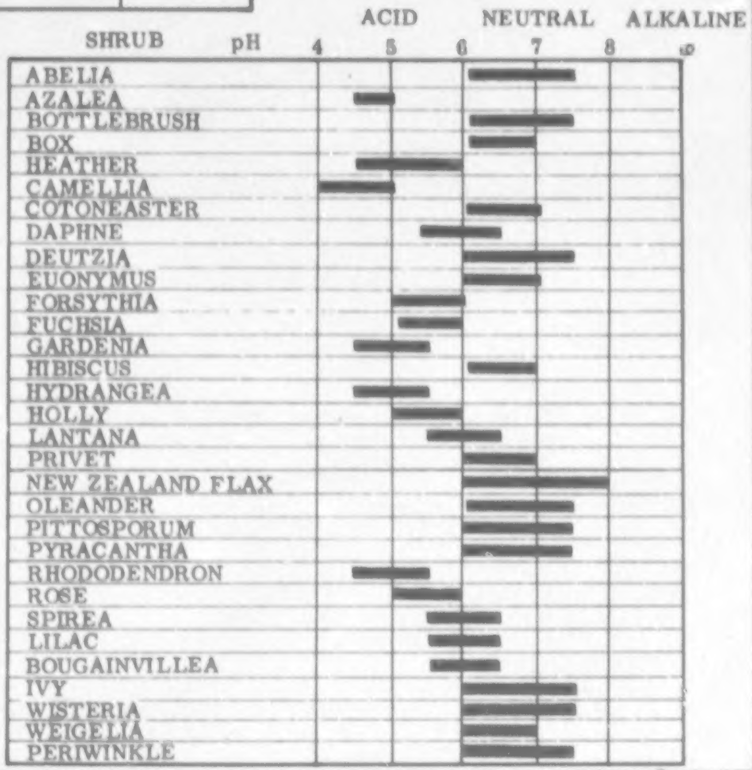
NOTE: AVAILABILITY OF NUTRIENTS TO PLANTS DECREASES AS WIDTH OF LINE DECREASES.



BEST SOIL pH RANGE







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CVAE AND VEH HORTICULTURE

Unit E: Soils and Plant Growth and Development

Topic 3: Compost, Mulches, and Soil Amendments

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

The procedure for preparing compost is given in the laboratory exercise at the end of the topic. It is suggested that class time be spent preparing a compost heap.

1. Compost

Compost is decomposed organic matter used as a mulch or to improve the soil. Manure, municipal refuse, sawdust, wood shavings, wood residue, and plant residue may be used as composting materials. Since compost contains a very small amount of plant nutrients, it is considered to be a soil amendment, rather than a fertilizer. Other amendments sometimes used as a substitute for compost are peat and sewage sludge.

Ways in which the application of compost will improve nursery soils are increased aggregation, pore space, water holding capacity, and crop yield after several years of use.

When compost is used as a soil builder, it is used in the same manner as manure and is applied in large quantities. When used as a mulch around and under plants, compost is applied two to three inches deep. It conserves moisture, lowers soil temperature in warm weather, keeps soil warmer in cold weather, aids in the control of weeds, and may add nutrients to the soil.

Microbe activity causes the decay of the materials and formation of compost. Some materials decompose much faster than others. Leguminous plant residue decomposes rather fast, while materials containing a high percentage of woody plants decompose rather slowly.

Since the cells of microbes contain from five to ten percent nitrogen, it may be necessary to add a nitrogen fertilizer to the heap in order to speed up decomposition. This, however, will depend on the composting materials used.

The compost heap is made by placing alternate layers of composting materials and manure or soil in a heap or bin. Each layer should be about six inches deep. In order for the composting materials to decompose, proper aeration, moisture, nutrients, and temperature must be provided. These elements and the kind of composting materials used will affect the time required for decomposition.

Since the height of the compost heap usually affects aeration, it is another factor that affects the time required for decomposition. Too much aeration, as well as too little, can affect decomposition. The nurseryman can regulate decomposition by the height of the compost heap and by the size of the particles of composting materials.

The ideal moisture content is from 50 to 70 percent. The weight of the moisture should be one to 2.5 times that of the dry organic material. If it is necessary to add moisture, it should be added in the form of a spray throughout the heap; however, to prevent the loss of nutrients, water should not be allowed to run out of the bottom of the pile.

Decomposition speed can be increased by turning the heap periodically. Commercial composting firms turn their heaps every three or four days. The nurseryman should turn his heaps at least every three weeks.

A by-product of decomposition is heat, which is produced by microbe activity. Several kinds of microbes are responsible for decomposition. One type initiates decomposition and continues activity until the temperature reaches 115 to 120 degrees F. The temperature at this level kills them, and another type takes over and raises the temperature to 140 to 170 degrees. When the temperature reaches this level, which lasts for two to three weeks, composting is proceeding. Composting is completed when the interior temperature drops to near the normal atmospheric temperature. Another method used to determine the completion of composting is to handle a small amount of the materials. If the materials are easily crumbled, composting is completed.

Transparency No. 1

One of the best ways of making compost is to use bins constructed of wood or concrete masonry units. Bins constructed of these materials will maintain moisture to the edge of the heap. The bin should be constructed so that one end is closed with removable boards. Being able to open one end allows the nurseryman to fill and work the heap with power equipment. Openings should be provided at the bottom of the bin to allow the entry of air. The size of a bin is determined by the amount of materials to be composted.

2. Mulches

The term "mulch" means to cover or to dress. The nurseryman uses mulches to cover the soil around plants, or to cover a plot of soil. Leaves, straw, sawdust, pine needles, wood chips, wood shavings, corn cobs, peat, paper, polyethylene, and gravel are some of the materials that may be used as a mulch.

Transparency No. 2

Some of the functions of mulching are given below:

1. Mulch serves as insulation and helps regulate soil temperature. It makes the soil warmer in winter and cooler in summer;
2. Mulch conserves soil moisture by keeping the soil cool and preventing evaporation;
3. Mulch prevents erosion by reducing the intensity of raindrops and slowing down run-off water;
4. Mulch prevents weed growth by preventing sunlight under the mulch;
5. Mulch provides organic matter after it decomposes;
6. Mulch can prevent fruit, such as strawberries, from becoming splashed with mud; and
7. Mulch can enhance the beauty of the landscape. White aggregrate is often used for this and other purposes.

The use of mulches also has disadvantages as well as advantages. Mulches can provide protection for rodents and insects and spread weed seed and diseases. A good mulch should be available in large quantities, easy to handle, and economical. The area in which the nursery is located will affect the availability and cost of mulching materials.

3. Soil Amendments

Soil amendments are materials added to the soil to change the characteristics of the soil. For example, lime is considered a soil amendment since it changes the activity of the soil to a more neutral state. Another soil amendment is peat moss. When peat moss is mixed with the soil, it creates a more favorable growing condition for plants. It increases aeration, water holding capacity, and availability of nutrients. Another soil amendment is sulphur. It increases the soil acidity. Other amendments are available and can be used very effectively.

Soil amendments may be classified into two groups: inorganic and organic. Inorganic additives are sand, perlite, vermiculite, calcined clay, lime, and sulphur. Examples of organic additives are peat, manure, straw, wood shavings, corn cob, etc.

LABORATORY EXERCISE

Activity: Prepare a compost heap

Materials:

Composting materials (leaves, straw, sewage sludge, or other materials)
Nitrogen fertilizer (amount needed depends on the amount of materials susceptible to decomposition by microbes)

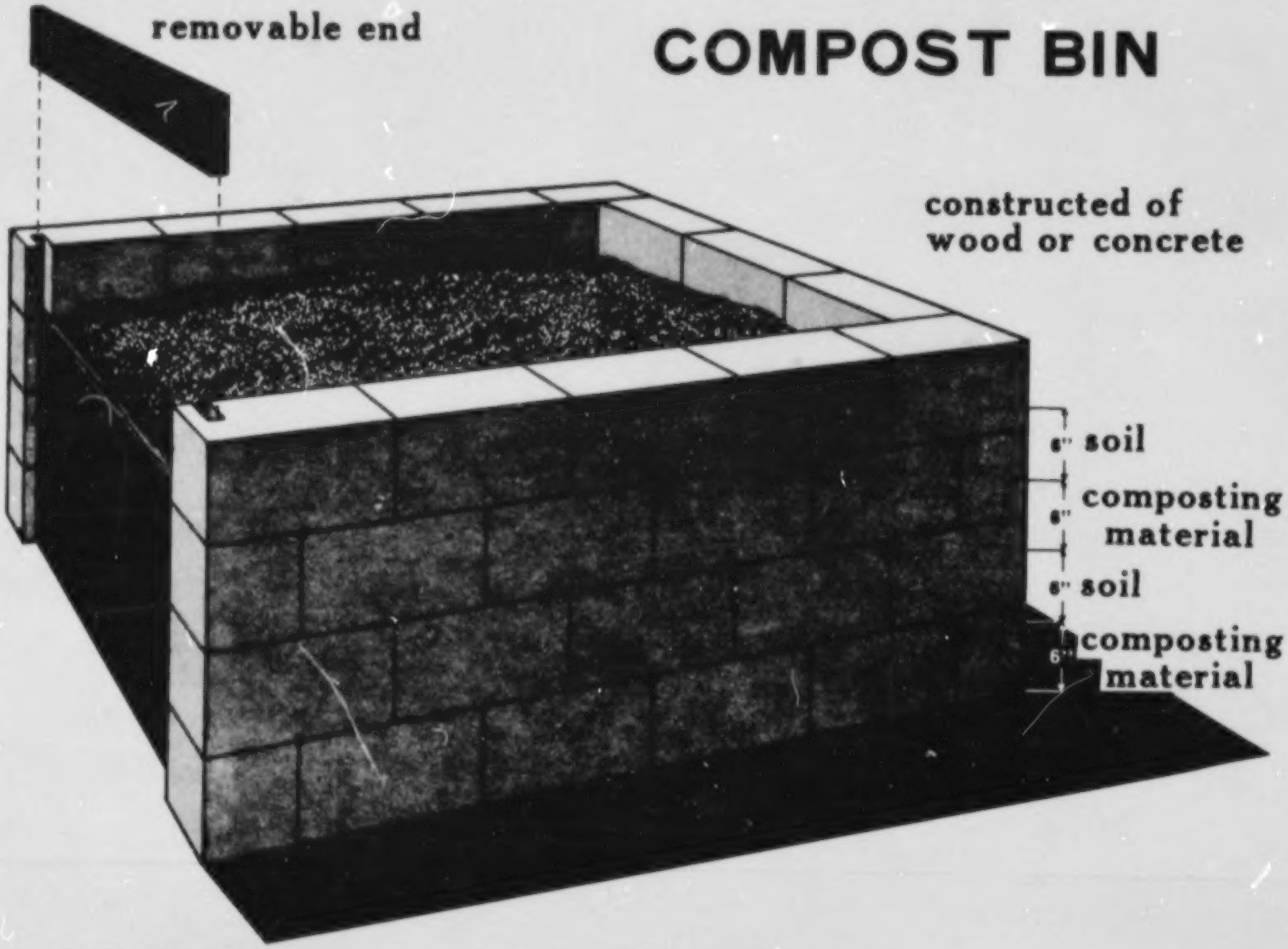
Compost bin
Shredder (use depends upon materials used)

Hose (to water heap)
Soil, or manure, or both

Procedure:

1. Composting materials are applied to a depth of approximately six inches in the bottom of the compost bin. It may be necessary to apply a nitrogen fertilizer on top of the composting materials to encourage microbe activity.
2. A six-inch layer of soil, or manure, or both, are placed on top of the composting materials.
3. Alternate layers of compost materials and soil or manure, or both, are placed in the bin until the bin is filled to the desired height.
4. Moisture is applied if needed.
5. The materials in the bin are turned periodically. The periods between turning the heap will determine the time required for the materials to decay.

COMPOST BIN


removable end
constructed of wood or concrete
6" soil
6" composting material
6" soil
6" composting material

FUNCTIONS OF MULCH

1. SERVES AS INSULATOR
2. CONSERVES MOISTURE
3. PREVENTS EROSION
4. PREVENTS WEED GROWTH
5. PROVIDES ORGANIC MATTER
6. PREVENTS MUD FROM SPLASHING FRUIT
7. ENHANCES BEAUTY

CVAE AND VEH HORTICULTURE

Unit E: Soils and Plant Growth and Development

Topic 4: Soil Sterilization

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

It is suggested that the students be allowed to conduct the laboratory exercise at the end of the topic.

1. Sterilizing Greenhouse Soils and Equipment

In order to prevent damage to greenhouse plants from soil-borne diseases and insects, the soil and equipment must be sterilized. Only a foolhardy operator would take the chance of not sterilizing.

Two methods used to sterilize soils are heat and chemicals. The method to use is determined by the availability of equipment, area to be treated, and media used.

Rather than invest money in sterilization equipment or chemicals, some growers use a sterile media to produce plants. A fungicide is mixed with the media to prevent damping-off. The media normally used is a mixture of sterile sand, perlite, and peat.

Sterilizing Soils with Heat

Steam, hot water, and baking are the three sources of heat used to sterilize soils.

Steam is probably the most often used source of heat in large greenhouses and is most effective. If properly used, it will kill soil-borne insects, bacteria, fungi, and viruses and will destroy weed seeds. Another advantage of using steam as a source of heat is that it promotes soil granulation.

Transparency No. 1

Prior to sterilization, the greenhouse soil should be prepared. Outlined below is the preparation procedure.

1. Humus and organic matter should be added.
2. Dry soil should be watered. Dry soils heat very slowly because they are poor conductors of heat. It is just as important not to overwater because excessive water will require more heat.

3. In order that weed seeds can sprout, the soil should be kept moist for six or seven days before the soil is sterilized. This will give these seeds an opportunity to germinate. Germinated seeds are much easier to kill.
4. Soil clods should be broken, and the soil should be well-aerated. This allows the heat to enter all of the soil.
5. If a steaming hose is used, it should extend the full length of the greenhouse benches. Buried tile will probably be used in ground beds.
6. Tables should be covered with plastic or some other suitable covering.

Transparency No. 2

The temperature and the length of time it is maintained will be determined by the insect or disease one is trying to control.

Certain precautions should be taken when heat is applied to soils. Excessive heat can cause a concentration of soluble salts (nitrogen, manganese, phosphorus, and potassium) which may damage plants. Also, overheating causes the organic matter in the soil to decompose much faster, and it may cause a toxic compound to form. The soil should be watered thoroughly after the application of heat so that soluble salts and toxic compounds are leached from the media.

Baking Soils to Sterilize Them - The 1/8 cubic yard, 240-volt soil pasteurizer is an economical method of sterilizing a small amount of soil and is a recommended item for pre-employment laboratory ornamental horticulture programs. Moist soils are placed in the pasteurizer and left there for the proper length of time.

Very small amounts of soils may be sterilized in the oven of a regular cook stove. The soil is placed in a pan and covered with aluminum foil before being placed in the oven. The timing should not begin until the soil reaches the desired temperature. This will require the use of a soil thermometer.

2. Chemical Sterilization of Soils

Chemicals are available that will control nematodes, fungi, bacteria, and weed seeds. Some of the available chemicals will control all of the pests mentioned above, while others control only a specific pest.

The chemical control of soil-borne insects and diseases is more effective in light sandy soils. Heavier, finer textured soil requires two to three times more chemicals than do sandy soils. The chemical control of pests in peaty soils is ineffective. The advantages of using chemicals to control soil pests are that their use does not disrupt the physical or chemical nature of the soil. Their main disadvantage is the high cost of application.

Soil fumigants and other chemicals are usually used when one of the following conditions exists: the overhead cost is low, the aeration of the soil is not expensive, weed seeds and seed-borne insects are the reasons for sterilization, and steam sterilization is not available.

Transparency No. 3

Several factors should be considered before preparing the soil for chemical sterilization:

1. Soil conditions - The soil should be in a good condition and ready for seeding.
2. Soil temperature - If fumigants are going to be used, the soil temperature should be from 50° to 85° F. for effective dispersion of the fumigant. The temperature should be taken at a depth of four to six inches.
3. Soil moisture - Soil having excessive moisture requires a larger application of chemical for sterilization. Moisture conditions should be normal.
4. Organic matter content- Sterilization is not as effective in soils having a high organic content. This is particularly true if fumigants are used.
5. Soil texture - Coarse textured soils are easier to sterilize.
6. Depth of application - The insect or disease one is trying to kill, available equipment, and the form of chemical used (liquid, granules, and powder) will determine the depth of application.
7. Safety - Always a major factor in any operation is safety. When chemicals are being applied, the manufacturer's recommendations should be followed; and the operator should wear safety goggles, avoid spilling chemicals on skin or clothing, avoid inhaling fumes, store chemicals properly, and clean application equipment with kerosene or fuel oil immediately after use.

After chemicals have been added to soils, a period of two to three weeks should lapse before using the sterilized soil for planting.

There are many methods of applying chemicals to greenhouse soils. A partial list is given below:

Chemicals to be applied in a liquid form may be applied through the automatic watering system in the greenhouse; powder and granular forms of chemicals may be worked into the soil; and fumigants may be released from pressurized containers under sheets of plastic or other desirable cover.

The following is a list of chemicals, the insects and diseases they should control, and the methods of application.

Chemical	Controls	Application and Remarks
Chloropicrin	Nematodes, damping-off seedling blights, weed seeds, soil insects, and soil-inhabiting disease organisms	A chloropicrin mask and canister should be used when applying this chemical.

Chemical	Controls	Application and Remarks
Methyl Bromide	Nematodes, grubs, cutworms, and other soil insects, weed seeds, damping-off, seedling blights, and other soil-inhabiting disease organisms	It should be applied with a special applicator under a gas-proof plastic cover. Delay planting for two weeks after application. It is extremely poisonous and cannot be used in soils where some plants are grown.
Vorlex	Nematodes, soil insects, weed seeds, soil-borne fungi	Application is the same as for chloropicrin. Delay planting for 2-3 weeks after application.
Vapam	Nematodes, germinating weed seeds, soil insects, soil-inhabiting disease organisms	Sprinkle uniformly over soil, and cover upper one inch of the soil with a water seal or gas-proof plastic film for 4 days after treatment. After soil has dried, cultivate 1-2" deep. Delay planting for 3-4 weeks after application.
Mylone	Soil fungi, weed seeds, nematodes, soil insects	It is applied as a drench, powder, or granules. Rake into soil, cover treated area with plastic cover, or apply water seal. Delay planting for 3-4 weeks.
Formaldehyde	Damping-off, seedling blights and other soil-inhabiting disease organisms, soil insects, germinatory weed seeds; a good disinfectant for tools and equipment	Three tablespoons of formaldehyde in a cup of water should treat a bushel of soil. Mix thoroughly with shovel. Cover with plastic or wet burlap for 48 hours after application. For mixing larger quantities use 1 gallon to 49 gallons of water. This may be used as a soil drench.

Other chemicals that may be used to control soil-borne insects and diseases are sinophos, trapex, nemes, brozone, dexon, and terraclor.

The following mixtures may be substituted for formaldehyde or other chemicals used in sterilizing tools, flats, posts, and benches:

1. 1% carbolic acid
2. Rubbing alcohol
3. Boiling water

LABORATORY EXERCISE

Activity:

Sterilizing soils by mechanical and chemical means

Materials:

Heat process

1. 1/8 cu. yd., 240 V soil pasteurizer or steam sterilizing equipment
2. Media or soil

Chemical process

1. Ample chemicals to perform demonstration
2. Plastic film or other suitable materials to cover soil if needed
3. Media or soil

Procedure:

Since most of the schools offering pre-employment laboratory ornamental horticulture programs have the 1/8 cubic yard, 240 V pasteurizer, it is recommended that it be used. Steps that might be used in demonstrating the pasteurizer are as follows:

1. Add the humus and organic matter to media.
2. Water media to proper moisture content. (Soils should be kept moist for 7 days before placing in the pasteurizer to allow weed seed to germinate.)
3. Soil is placed in pasteurizer.
4. Explain operation of pasteurizer.

Steps to follow in the chemical sterilization of soils:

1. Prepare soils for fumigation or other chemical treatment. (Temperature, condition, moisture, and organic matter content are checked and corrected if necessary.)
2. Explain safety precautions that should be taken in applying chemicals.
3. Apply chemicals.
4. Use proper follow-up procedure (cover with plastic, etc.)

References:

1. Moore, Stanley B., Ornamental Horticulture as a Vocation, Munkus Publishing Company, Inc., Fairborn, Ohio, 1969.

2. Laurie, Alex and others, Commercial Flower Forcing, McGraw-Hill Book Company, New York, 1969.

PREPARING THE SOIL FOR HEAT STERILIZATION

- ADD HUMUS AND ORGANIC MATTER TO SOIL
- WATER DRY SOIL
- KEEP SOIL MOIST FOR SIX OR SEVEN DAYS BEFORE STERILIZING TO SPROUT WEED SEEDS
- BREAK UP CLODS AND AERATE BEFORE STERILIZING
- STEAM HOSE SHOULD EXTEND LENGTH OF BEDS
- COVER TABLES WITH PLASTIC OR OTHER SUITABLE COVER TO RETAIN HEAT

KILLING TIME FOR VARIOUS SOIL ORGANISMS WHEN USING STEAM STERILIZATION

TEMPERATURE	LENGTH OF TIME	ORGANISM
140° F.	IMMEDIATELY	INSECTS, NEMATODES
140—160° F.	10 MINUTES	WEED SEEDS, FUNGI, BACTERIA
180° F.	30 MINUTES	VIRUS

FACTORS TO CONSIDER IN PREPARING THE SOIL FOR CHEMICAL STERILIZATION

- SOIL CONDITION
- SOIL TEMPERATURE
- SOIL MOISTURE
- ORGANIC MATTER CONTENT
- SOIL TEXTURE
- DEPTH OF APPLICATION
- SAFETY

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CVAE AND VEH HORTICULTURE

Unit E: Soils and Plant Growth and Development

Topic 5: Fertilizers

Note: All terms underlined are included in the "Glossary of Terms"

Suggested Procedure and Activities:

Four laboratory exercises pertaining to the testing and preparing of soil samples are included.

1. Classification of Plant Food Elements

Soil scientists have determined that 16 essential plant food elements are required by plants for growth. These are called essential elements because plants will not complete their cycle if they are not available. While three of the elements- carbon, hydrogen, and oxygen - may be obtained by plants from water and carbon dioxide, the remaining 13 must be supplied to the soil or growing plant.

Transparency No. 1

The 13 elements that must be supplied are classified into three categories. These are primary, secondary, and micro-nutrients. Plants require relatively large amounts of primary and secondary nutrients, but very small amounts of micro-nutrients.

Primary Elements

Primary elements are nitrogen, phosphorus, and potash. A fertilizer containing all three of these elements is referred to as a complete fertilizer.

Transparency No. 2

The percentage of each of the three primary elements in a fertilizer is known as the fertilizer formula. The formula determines the price of the fertilizer. An example of a formula is 13-13-13. The first figure in the formula represents the percentage of nitrogen; the second is the percentage of phosphorus; and the third represents the percentage of potash.

All fertilizers in the dry form contain an inert substance called filler. Filler reduces the concentration of the mixture and makes it easier to apply. For example, a 50 pound sack of 10-20-10 contains a total of 20 pounds of plant food elements (5lbs. of N., 10 lbs. of P., and 5 lbs. of K.) and 30 pounds of filler. Filler is also called carrier.

Another term used by the fertilizer industry to designate the amount of plant food is a unit. A unit of plant food is one percent of a ton or 20 pounds. A ton of 13-13-13 fertilizer contains 13 units of each of the primary elements.

Still another term used by those working in the industry is ratio. The ratio is a comparison of the percentages of the elements in the mixture. A 13-13-13 analysis fertilizer has a 1-1-1 ratio, while a 10-20-10 analysis has a 1-2-1 ratio. Assuming the rate of application recommended from a soil test was 120-60-60, the grower would apply 600 pounds of 20-10-10 (2-1-2- ratio).

Transparency Nos. 3A and 3B

The importance of each element and sources are given below:

NITROGEN

Source	Importance
Urea (46-0-0) Ammonium Nitrate (34-0-0) Ammonium Sulfate (34-0-0) Sodium Nitrate (16-0-0) Calcium Nitrate (15-0-0) Potassium Nitrate (13-0-44)	It promotes growth, gives the plant a dark color, improves quality of leafy plants. A nitrogen deficiency causes short stems, small leaves, and a pale color in the leaves and flowers.

PHOSPHORUS

Superphosphate (-020-0) Mono-Calcium Phosphate (11-48-0) Mono-Potassium Phosphate (0-52-34) Mono-Ammonium Phosphate (12-61-0)	Phosphorus is necessary for root formation and rapid growth. It hastens maturity, is necessary for seed formation, and is required for enzyme action. A phosphorus deficiency decreases growth and slows maturity.

POTASH

Potassium Nitrate (13-0-44) Potassium Chloride (muriate of potash, 0-0-50) Potassium Sulfate (sulfate of potash, 0-0-50) Fritted Potash (0-0-29)	Plants need potash to form carbohydrates and proteins. It increases vigor, helps plants resist disease, increases plumpness of seeds, and improves plant quality. A deficiency causes elongation of plant cells, rather than cell division.

Secondary Elements

Elements in this classification are calcium, magnesium, and sulfur. Sources of these elements and their importance in the growing of horticultural plants are as follows:

CALCIUM

Source	Importance
Calcium Sulfate Ground Limestone Hydrated Lime Agricultural Gypsum Dolomite Limestone	Calcium promotes root formation and influences the synthesis of plant nutrients. A deficiency causes death of terminal buds at tips and leaf margins.

MAGNESIUM

Source	Importance
Magnesium Sulfate Aluminum Sulfate	It influences intake of plant nutrients, aids in translocation of phosphorus and starches and is necessary for the formation of fats. A deficiency causes leaf veins to turn yellow and leaves to become mottled. Stems become tender and weak.

SULFUR

Source	Importance
Calcium Sulfate Magnesium Sulfate Iron Sulfate Ground Sulphur	Sulfur promotes root growth. A deficiency causes young leaves to become light green in color, and stalks to become long and slender.

Micro-Elements

Zinc, molybdenum, copper, iron, manganese, and boron are within this group. These are needed in very small quantities by plants but are essential for growth. They are usually applied as a complete micro-element complex but may be applied individually. The complex is usually formulated in the chelated or partially chelated form and in the proper proportions for greenhouse media and soils. The complex is easier to apply and handle and safer to use. It is available in the fritted form, a slow release of the elements.

Recommendations for the application of the primary elements are given in the following chart.

Chart No. 1

2. Kinds and Blends of Fertilizers

These are two kinds of fertilizers, organic and inorganic. Organic fertilizers are usually derived from plant and animal residue. These are not available in sufficient quantities to supply all of the grower's needs. Inorganic fertilizers are produced from chemicals or synthetics. Chemicals usually contain a higher percentage of plant food nutrients. However, they also cost more.

Plants are unable to use inorganic fertilizers in their elemental forms. The elements in the fertilizers are combined with other elements and form chemical compounds, which are used by the plants.

Mixed or complete fertilizers are manufactured by mixing the elements together. Most manufactured fertilizers contain more than one element. However, they may be purchased and applied as single elements.

Fertilizers are available in three forms: solid, liquids, and suspensions. The contents of the suspension form is called a slurry. The substances in the slurry do not dissolve and are kept in suspension by agitation or a suspension agent.

Numerous kinds and forms of fertilizers are available today. A recent introduction by fertilizer manufacturers are the quick, slow, and mid-release types. These are particularly useful in the feeding of container grown plants. The nutrients are locked inside a coating which dissolves slowly with each watering. The fertilizer release period may be from one month to a year. One should be aware that damage to the coating can affect the release time.

A nutritional problem can be corrected quickly by using a quick acting synthetic fertilizer. By placing a mid-release capsule in the pot at the nursery, the commercial grower's plants will have a healthy, lush appearance after being placed on display by the retailer.

The following chart is a partial listing of some of the different kinds and forms of fertilizers available. The grower should read the product label and follow directions.

Chart No. 2

3. Soil Testing

In order to obtain maximum growth from plants, the grower must have a knowledge of the amounts of nutrients contained by soils. The most accurate means of securing this information is a soil test. In addition, the soil test includes a recommendation as to the nutrients that should be added to the soil. Applying fertilizer without the results of a soil test could be a waste of fertilizer.

Soil Sampling and Analysis

Several soil testing laboratories are located in the state. Many growers send samples to the Soil Testing Laboratory at Texas A&M University, College Station, TX. After running the test, the laboratory provides the producer with the soil pH and available phosphorus and potash of the soils sampled. The amount of available nitrogen is included by some laboratories, but generally the nitrogen recommendations are based upon the crop to be grown, soil type, yields desired, and previous crops grown.

For the soil test to be an accurate analysis of the soil, the sample must be representative of the soils in the field in which the sample was taken. The horticulturist should follow the recommended procedure and give careful attention to details when taking the sample.

The soil sample may be taken most any time of the year, but the soil should be dry enough to work when it is taken. The time to take the sample for spring crops is in the fall, and the sample for fall crops should be taken in spring. Samples should be taken well in advance of the time the crop is to be planted and should be taken annually for continuous crops and once per rotation for rotated crops. The procedure used for taking samples is explained on the back of Chart No. 3A and 3B.

Chart Nos. 3A and 3B

The information sheet should be filled out as completely as possible because the fertilizer rates depend on the type of soil, crop to be grown, past cropping and fertilizer used, and expected yields, as well as the soil test.

4. Method, Rate, and Time of Application

The method of application is extremely important, as an improper application may result in a loss of plant food. The placement of fertilizer will determine its availability to plants. It is possible when applying liquid and gaseous fertilizers and broadcasting dry fertilizers to cause fixation, which prevents the fertilizer from becoming available to the plants. The fertilizer must be placed so that the plant roots can come in contact with it. However, precautions should be taken to prevent the placement of fertilizer too close to the root system or seeds. Placing the fertilizer too close to the plant or seed can cause damage to the plant or seed.

Such factors as crop to be grown, condition of soil, equipment available, and condition of seedbed should be considered in determining the method of application. An explanation of several methods of applying fertilizers is given below:

(1) Banding - A band of fertilizer is placed either 2 to 3 inches to the side and 2 to 3 inches below the seed, or it is placed 3 to 6 inches below the seed.
(2) Topdressing - Nutrients are supplied to nursery crops by drilling them into the top soil. A drill attachment is used to apply fertilizer by this method.
(3) Sidedressing - Sidedressing is usually restricted to the application of nitrogen and potassium. When cultivation is practiced, sidedressing is usually done about the time of the first cultivation. Sidedressing reduces the loss of plant

nutrients by leaching. It can be done when the moisture conditions are favorable. The main precaution is not to place the fertilizer too close to the plant. Side-dressing can be done 2 to 4 weeks after planting.

(4) Broadcasting - After the fertilizer is applied to the surface, it may be disked into the soil. Clay soils reduce the availability of phosphorus to the plant; that is, if the phosphorus is broadcast instead of banded.

(5) Applying in Irrigation Water - Nitrogen can be applied to the soil efficiently and evenly by adding it to the irrigation water. Since phosphorus tends to remain on the surface, it is usually applied by other methods.

(6) Foliage Spray - Foliar feeding of plants is generally satisfactory for applying most trace elements directly to the leaves. The major elements cannot be applied in this method due to so many applications being required to furnish a sufficient amount of plant nutrients.

(7) Aerial Applications - Areas with rough land or dense forest can be fertilized by plane. Usually coarse, granular, or pelleted material is used for aerial distribution. This form of application is considered a broadcast method.

Fertilizer Rate

Soil type, climatic conditions, weather conditions, management practices, and soil test result are factors that will determine the rate of application. The soil test is the best method of determining rate of application. Another method of determining rate of application is to have several test plots in the nursery. The test plots are staked off in order that an accurate comparison can be made and within the regular nursery plots. Different rates of fertilizer are applied in these plots, and a comparison is made of the plants in the test plots with those in the regular plot. It is recommended that test plots be located near the center of the field, for the results are more representative.

A producer may not wish to apply a rate of fertilizer that will give him maximum growth; he may wish to apply a rate that will give a maximum return per dollar of fertilizer.

LABORATORY EXERCISE

Four different laboratory exercises are included in this topic. Exercises are numbered one, two, three, and four.

Activities:

1. The testing of media for soil constituents (The teacher may wish to test the media for one or all of the following: nitrogen, phosphorus, potassium, calcium, magnesium, iron, and manganese.)
2. The testing of media or soil to determine pH.
3. The application of one or more elements. This demonstration may be performed with both form (dry or liquid) of elements.
4. Prepare a soil sample for a soil test.

Materials:

1. Testing media for soil constituents
   - a. Soil testing kit
   - b. Sample media or soil
2. Testing media or soil to determine pH
   - a. Beckman Zeromatic pH meter or similar meter
   - b. Sample media or soil
3. Application of one or more elements
   - a. Sample media or soil
   - b. Application equipment
     The form (dry or liquid) in which the elements will be applied will determine the materials needed. If it is applied in the dry form, equipment for mixing will be needed; and if applied in a liquid form, either a hozon nozzle, automatic injection equipment, ooze hose, or siphon nozzle will be needed.
4. Preparing a soil sample
   - a. A clean bucket
   - b. Soil probe auger or spade
   - c. Knife (used to clean probe, auger, or spade)

Procedure:

1. Testing media for soil constituents
   - a. Sample of media or soil is secured.
   - b. Testing kit instructions are followed.
2. Testing media or soil to determine pH
   - a. Sample of media or soil is secured.
   - b. Instructions accompanying pH meter are followed.
3. Application of one or more elements
   - a. If the dry form of an element(s) is used, it should be mixed by hand. The elements should be thoroughly incorporated into the media or soil.
   - b. If the liquid form of an element(s) is used, the procedure to follow will be determined by equipment available.
4. Preparing a soil sample
   - a. Debris is scraped off of the top of the soil.
   - b. The sample is taken to the depth in which the soil is plowed. Lawn soil samples are taken to a depth of three inches. A sample should not be taken where fertilizer has been banded. If the nursery plot is in rows, the soil sample should be taken in the middles. Samples should not be taken from dead furrows, turn rows, near large trees, old fence rows, and fertilizer and lime spills.
   - c. A sample should be taken of each of the different soils or different soil conditions in the plot. At least 10 samples should be taken from a plot.
   - d. The samples are thoroughly mixed. After mixing, a pint container should be filled and prepared for shipment to the laboratory.
   - e. The Soil Sample Information Sheet is completed and mailed to the laboratory with the sample.

f. If more than one sample is sent to the laboratory for testing, the nurseryman should keep a record of the plot from which each sample was taken. Numbering the samples will help the nurseryman keep accurate records.

Recommended Application of Some Fertilizer Elements

Elements	Bench- or bed-grown plants		Pot-grown plants		
	Dry lbs. per 100 sq. ft.	Liquid oz. per gallon of water	Dry lbs.	Liquid (Apply weekly or every other week)	
				Young plants	Established plants
Nitrogen					
1. Urea	¼	1 to 7	1 to 3 for each 2½ bu. (1 wheelbarrow)	20 to 50 ppm	75 to 90 ppm
2. Ammonium nitrate	½	1 to 5	"	"	"
3. Ammonium sulfate	1	1 to 2	"	"	"
4. Sodium nitrate	1	1 to 2	"	"	"
5. Calcium nitrate	1	1 to 2	"	"	"
6. Potassium nitrate	1	1 to 2	"	"	"
Phosphorus					
1. Superphosphate	5	1 to 5	"	"	"
2. Mono-calcium phosphate	1	1 to 2	"	"	"
Potash					
1. Potassium nitrate	1	1 to 2	"	"	"
2. Potassium chloride	1	1 to 2	"	"	"
3. Fritted	3	not recommended	"	"	"

SOME KINDS AND FORMS OF FERTILIZER AVAILABLE

Brand Name	N-P-K	Trace Elements Listed	Frequency of Application	How Applied
CAPSULES, SPIKES, SPRAYS AND TIMED-RELEASE				
Dramm Mini-Pill	14-4-6	-	4 months	on top of soil
House in Bloom	7-7-7	-	3-4 weeks	spray onto soil
Jobe's Houseplant Spikes	12-6-6	-	2 months	bury in soil
Ortho General Purpose Plant Food	12-6-6	-	3-4 months	work into top of soil
Osmocote	14-14-14	-	3-4 months	mix into potting soil
Plantabbs	11-15-20	-	1-½-2 months	dissolve in water
Precise Plant Food	12-6-6	-	3-4 months	work into top of soil
LIQUID CONCENTRATES				
Agro Fish 'n Six	14-6-8	6	2-3 weeks	dilute in water
Cole's 100% Organic (from seaweed)	0.28-0.02-0.07		---	foliar spray
Dr. Sher's Gourmet Food for Plants Foliage & Leaf Diet	15-5-5	8	every watering	dilute in water
Eco-Gro Fish & Seaweed Fertilizer	8-4-4	-	3-4 weeks	dilute in water
Liquinox Bloom	0-10-10	-	3-4 weeks	dilute in water
Liquinox Grow	10-10-5	-	2 weeks	dilute in water
Ortho House Plant Food	5-10-5	3	weekly	to soil
DRY MIXES				
Agro Aqua Feed	20-20-20	-	---	foliar or in water
Eco Grow	10-8-14	12	1-3 weeks	dissolve in water
Hyponex House Plant Food	7-6-19	-	weekly	dissolve in water
Miller's Booster House Plant Formula	5-10-14	9	7-10 days	dissolve in water
Nulife Soluble Plant Food	20-20-20	-	weekly	foliar or in water
Restore Foliage Plant Formula	3-4-4	-	every watering	dissolve in water

D-495

TEXAS AGRICULTURAL EXTENSION SERVICE
THE TEXAS A&M UNIVERSITY SYSTEM
SOIL TESTING LABORATORY

SOIL SAMPLE INFORMATION SHEET
FOR
LAWNS, GARDENS AND FLOWER BEDS

This form is to be used for lawns, gardens and flower beds. Please fill out as completely as possible and mail with the soil samples. See opposite side for instructions on how to take samples and instructions for mailing. Be sure to enclose a check or money order for correct amount of fee.

NAME______________________________________

ADDRESS______________________________________

COUNTY____________________ Date________________

POST OFFICE__________________ Zip________________

Cost per sample (check)

Regular tests $2.00__________

Regular tests plus iron, zinc and manganese $5.00__________

Laboratory number (do not write in this space)	Your sample number	Condition of topsoil				Remarks
		Loose	Heavy	Packed	Mellow	(soil conditions)

Your sample number	Commercial fertilizer used		Organic material used (manure, compost, etc.)		Plants to be grown (lawn, vegetables, flowers, shrubs, trees)
	Kind	How much	Kind	How much	

Give size of area (dimensions or number of square feet) :____________________

How many years has garden (or lawn or flowers) been in this spot?________________

Do you have manures, compost, leaves or other organic material available each year? (Yes or No)__________ If so, how much?________________

What particular difficulties do you have with plant growth in this area?________________

____

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AGR 11-3

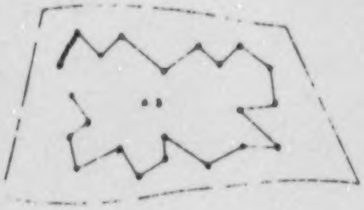
INSTRUCTIONS FOR TAKING SOIL SAMPLES
from
Lawns, Gardens and Flower Beds

Soil tests can be only as accurate as the samples on which they are made. Therefore, proper collection of samples is extremely important.

Step 1.

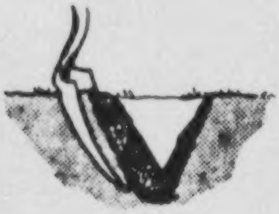
Take at least one separate composite sample for each soil difference or soil condition. Differences can be due to texture, slope, color, drainage or past treatment. For example, if one area is sandy and another is heavier, take 2 separate composite samples. (Note: If sample is taken from problem area, such as bare spots in lawn, it is necessary that one composite sample come from the problem area, and one composite sample from the surrounding good area. See note on plant diseases below.)

Step 2.



For a composite sample, obtain at least 10 samples from the area, put in a clean container (bucket, sack, etc.) and mix thoroughly. Take out about 1 pint. Place in a clean container, such as an ice cream carton or paper sack, and submit for testing.

Step 3.



To take a sample, use a garden trowel or spade. Dig a V-shaped hole, then take a ½-inch slice from the smooth side of the hole. Place in a bucket and repeat in about ten places. Take samples to a depth of 6 inches in flower beds and gardens and 4 inches in lawns. A soil probe or soil auger also can be used.

Step 4.

Label each sample with number and name. Be sure to keep a record of the area from which the samples came. Fill out the opposite side of this sheet as completely as possible and submit with the sample to the Soil Testing Laboratory.

Note on Plant Diseases

If grasses, vegetables or flowers die, it is very seldom due to a lack of soil fertility, but is probably due to some other factor. If this is the case, a soil test would be of little value. If difficulties in plant growth appear to be due to diseases, see your county Extension agent for diagnosis and further information.

Educational programs conducted by the Texas Agricultural Extension Service serve people of all ages regardless of socio-economic levels, race, color, sex, religion and national origin.

MAILING INSTRUCTIONS

For each soil sample to be tested there will be a charge of $2 or $5 (see front). MAKE REMITTANCE PAYABLE TO SOIL TESTING LABORATORY. Place remittance and Information Sheet in an envelope and attach this envelope to package containing the sample or samples to be tested so that all the material will reach the Laboratory at the same time. Address to: Soil Testing Laboratory, Texas Agricultural Extension Service, The Texas A&M University System, College Station, Texas 77843, or to Soil Testing Laboratory, County Extension Office, Texas Agricultural Extension Service, Seymour, Texas 76380, or to Soil Testing Laboratory, Texas Agricultural Extension Service, Route 3, Lubbock, Texas 79401. Envelope containing remittance and Information Sheet will require first-class postage; package containing soil sample or samples may be sent parcel post.

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FOR FURTHER DETAILS CONSULT YOUR COUNTY EXTENSION AGENT Chart No. 3B

CLASSIFICATION OF FERTILIZER ELEMENTS

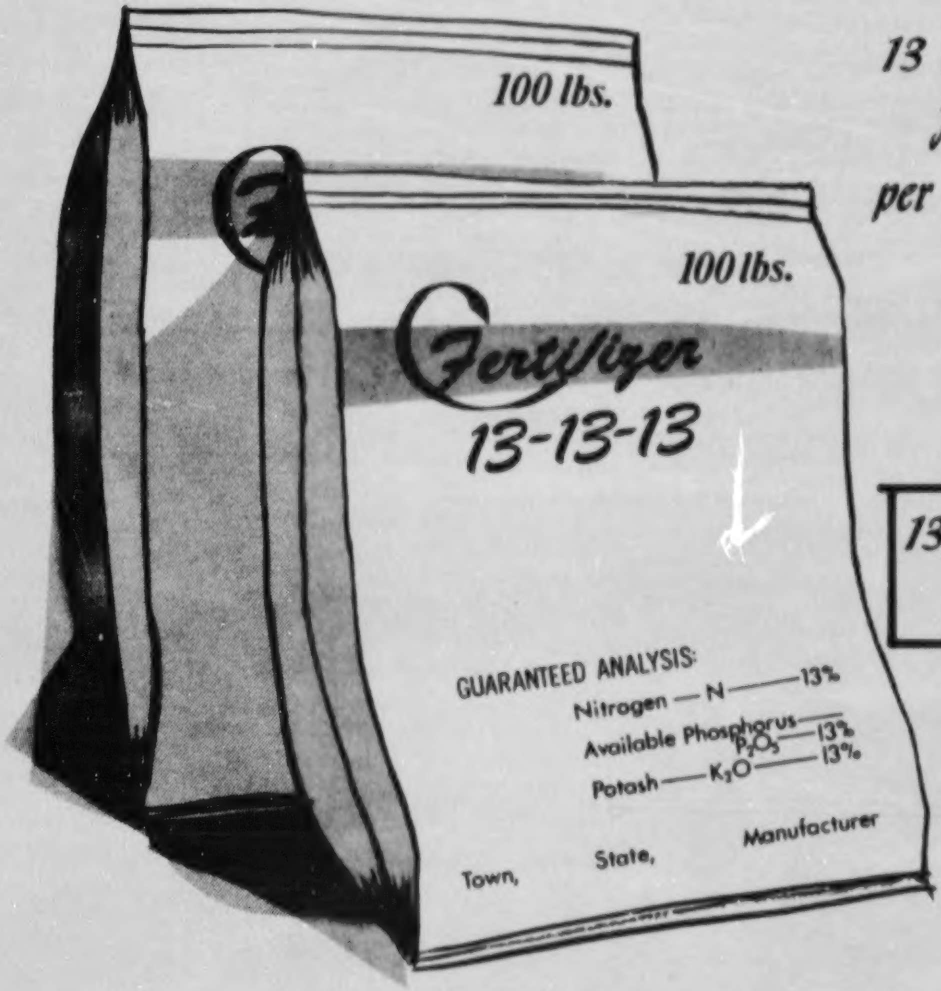
PRIMARY: NITROGEN (N), PHOSPHORUS (P; P_2O_5), AND POTASSIUM (K; K_2O)

SECONDARY: CALCIUM (Ca), MAGNESIUM (Mg), AND SULPHUR (S)

MICRONUTRIENTS:

BORON (B), COPPER (Cu), IRON (Fe), MANGANESE (Mn), MOLYBDENUM (Mo), ZINC (Zn), AND CHLORINE (Cl)

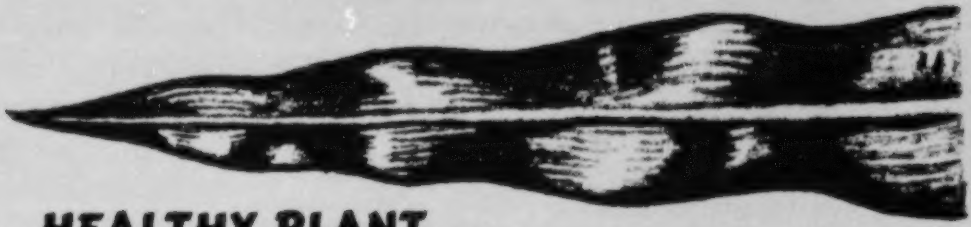
FERTILIZER BLENDS


100 lbs.
100 lbs.
Fertilizer
13-13-13
GUARANTEED ANALYSIS:
Nitrogen — N — 13%
Available Phosphorus — P2O5 — 13%
Potash — K2O — 13%
Town, State, Manufacturer

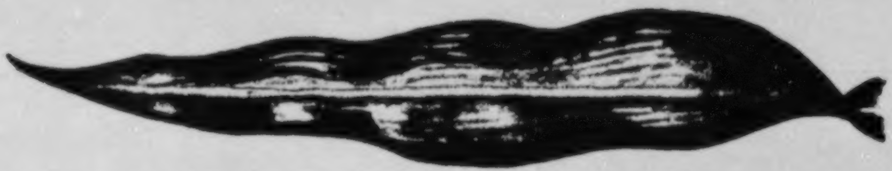
13 lbs. of Each Primary Nutrient - 39 lbs. per 100 lbs. of Fertilizer

$13N - P_2O_5 - 13K_2O =$ 1 - 1 - 1 Ratio

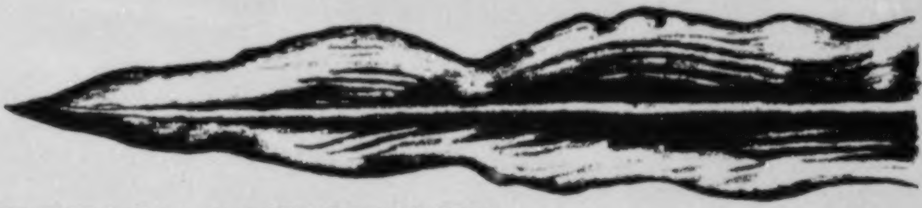
DEFICIENCY SYMPTOMS



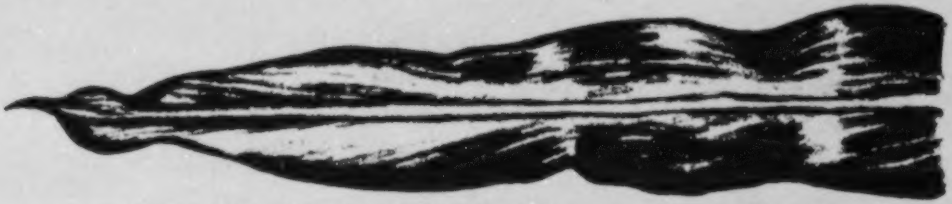
HEALTHY PLANT



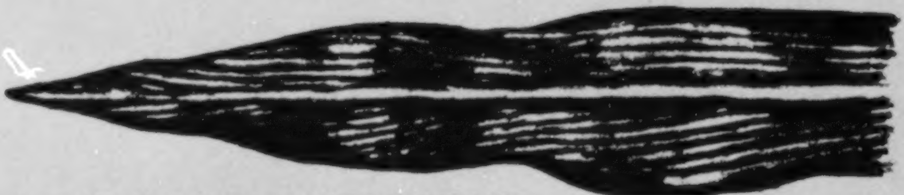
PHOSPHORUS DEFICIENCY



POTASH DEFICIENCY

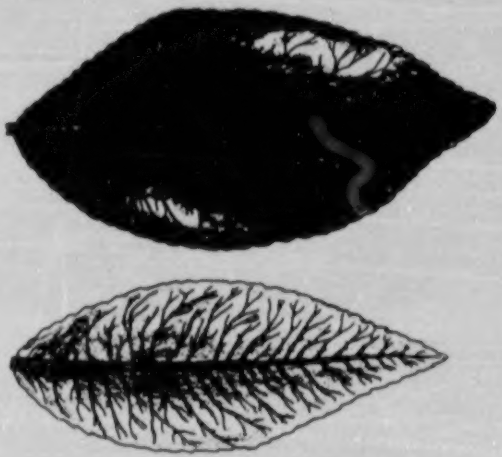


NITROGEN DEFICIENCY

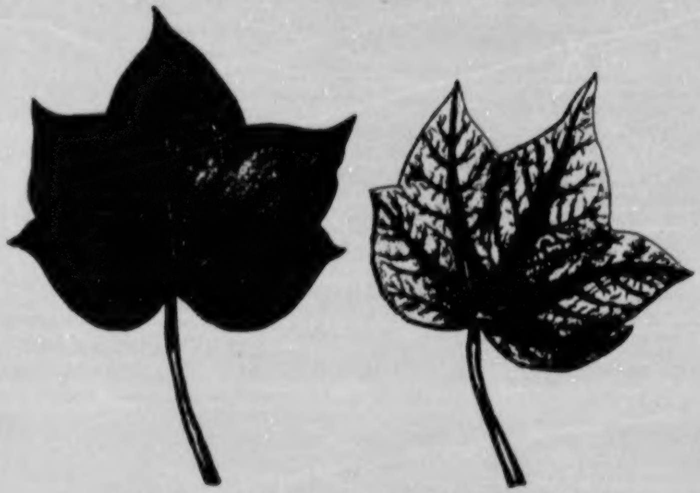


MAGNESIUM DEFICIENCY

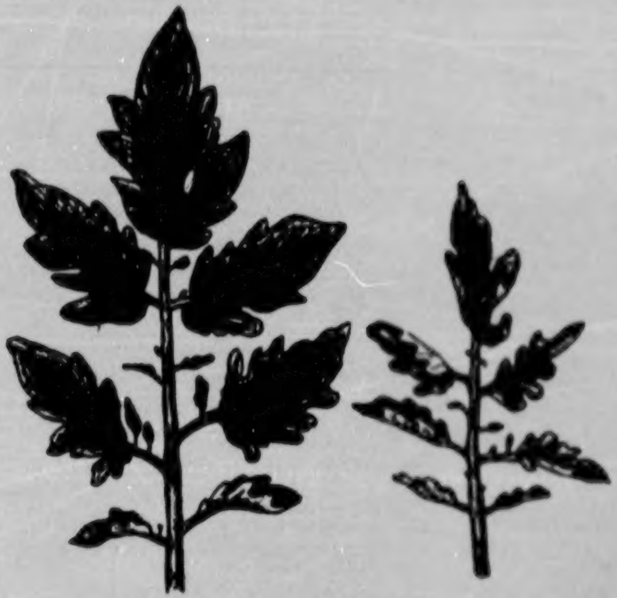
DEFICIENCY SYMPTOMS



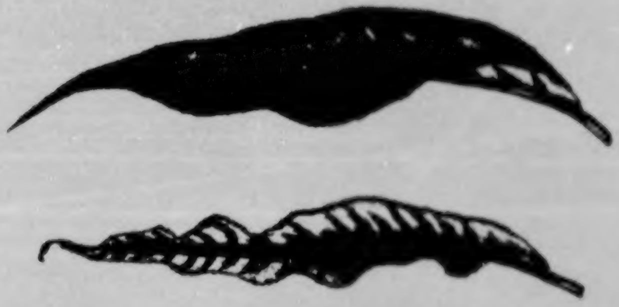
IRON DEFICIENCY



MANGANESE DEFICIENCY



COPPER DEFICIENCY



ZINC DEFICIENCY

Vocational Instructional Services
Agricultural Education

E-6
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit E: Soils and Plant Growth and Development

Topic 6: Plant Growth and Development

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Using the laboratory exercise to demonstrate the process of osmosis should assist the student in understanding the process.

1. Plant Growth

An understanding of plant growth and development will help the grower recognize the changes taking place (metabolic processes) as plants grow. Requirements for growth change as plants grow.

Transparency No. 1

Most plants have the following parts: roots, stems, leaves, flowers, fruit, and seed. The roots, stems, and leaves are the vegetative parts (growing parts) of a plant. Flowers, fruit, and seed are the reproductive parts. These are called the reproductive parts because new plants may be produced from these parts.

Plants are made up of cells. Cells have several sides and are cubical to elongate in shape. Cells contain the plant food, water, and other substances necessary for growth, development, and reproduction. The enlargement and division of cells cause plants to grow. Also contained in the cells are the heritability characteristics of plants.

A discussion of some of the parts of plants and their functions is given below.

Plant Roots

The roots of plants have two functions: (1) to serve as an anchor for the plant, and (2) to absorb water and nutrients (mineral salts). Water enters the plant through root hairs and other root surfaces not covered with cork. Root hairs live only about 25 hours; but under favorable conditions, new root hairs are continuously being developed. Leaves must furnish an adequate food supply for the root hairs to develop. Also adequate moisture must be available for the roots to develop. However, too much moisture will cause a reduction in oxygen and the plant to die.

Plant Leaf

The leaf is a flat part or extension of the stem. It provides a surface which allows the absorption of light energy. The transpiration process is governed by light and other factors. The three parts of a leaf are (1) petiole, (2) blade, and (3) stipules

The petioles support the leaves, but all plants do not have petioles. The leaves of some plants are attached directly to the stem. Transpiration and photosynthesis the most important growth processes, take place in the leaf.

Transpiration is the movement of vapor through the openings on the underside of plant leaves. In simple terms, it may be described as the evaporation of moisture through the leaves. Even in areas of high humidity, such as a greenhouse, transpiration must take place. Air movement is necessary for transpiration.

Photosynthesis is the manufacturing of food by plants. "Photo" means light, and "synthesis" means putting together. This process furnishes energy for the plant. During the photosynthesis process, plants manufacture food (carbohydrates) and release oxygen.

Plant Flower

Sepals, petals, stamen, and pistil make up the parts of a flower. Sepals cover the petals. Many greenhouse plants are grown because of the color of their petals.

Reproductive parts of the flowers are the stamen (male) and pistil (female). The stamen produces the pollen which fertilizes the pistil and causes the plant to produce seed or fruit. Following fertilization by the pollen, the flowers of many plants will wilt, while others remain in good condition for a period of time.

A more detailed discussion of the parts and functions of plant flowers is given in Unit F, Topic 1.

2. Absorption of Water and Nutrients by Plants

Although the leaves of plants can absorb water and nutrients, usually these are taken into the plant through its root hairs, located near the tip of the roots. The tiny root hairs push their way into the soil and expose themselves to moisture and nutrients. After being taken into the plant, water and nutrients pass through cell walls and membranes.

Movement of water and nutrients from the roots to the rest of the plant is by diffusion, a process caused by osmosis. Osmosis is the movement of a substance from a place of greater concentration (root hairs) to areas of less concentration (rest of plant).

Wilting of plants is caused by the rate moisture is absorbed and evaporated. If moisture evaporates faster through the openings (stomates) in the underside of plant leaves than it is being taken in by the roots, the plant wilts. This normally happens when the atmospheric and leaf temperatures rise. Most students have seen field crops wilt during a hot summer day.

3. Reproductive Cycle of Plants

The six steps in the reproductive cycle of greenhouse plants are as follows:

1. Formation of the male(stamen) and female(pistil) parts of the flowers;
2. Opening of the flower (the male and female parts of the flower are sexually mature during this stage.);
3. Pollination (pollen is transferred from the male parts to the female parts by wind or insects.);
4. Fertilization;
5. Growth of fertilized egg and its development into seed (embryo); and
6. Maturing of the seed.

Life Processes of Plants

These processes are affected by a number of factors, but the two most important are discussed below.

Light and its effect upon flowering and seed production are discussed first. It was discovered in 1919 by Dr. W. W. Garner and Dr. H. A. Allard that light affects plant growth. Plants that require a short daylight period will not flower if provided with too much light. In a like manner, plants requiring a lot of daylight will not flower if the light period is not adequate. Other factors affected by the light period are germination, growth habits, and seed production. The dropping of leaves in the fall by deciduous plants is caused by limited daylight or short days.

Another factor greatly affecting the life processes of plants is the temperature. During warm weather most deciduous plants form leaves, manufacture food, and grow. In cold weather leaves are dropped, visible growth stops, and the plant rests. This is the dormant period. Plants would not survive if they did not become dormant when the temperature reaches 32° F. The colder temperature causes the plant to harden so that it can withstand the weather.

The rest or dormant period begins shortly after the outer growth (terminal growth) stops. It appears that the rest period starts with the buds at the base of the plant and moves upward. The buds may be resting while the shoots are still growing. Although it may not be visible, buds develop during the rest period.

In order for buds to resume normal growth in the spring, the rest period must be broken during the winter. To break the rest period, the plant must have a number of hours of cold temperature. The number of hours required is determined by the variety and kind of plant. The rest period can be broken with a temperature of 40° F. or colder. Plants which do not receive enough cold weather require longer to produce fruit, thus the fruit crop is reduced. The amount of chilling temperature is particularly important in the selecting of fruit tree varieties.

When plants have been adequately chilled, the buds in the center of the tree are the first to break dormancy. These buds require less chilling than one-year-old buds, which are found on last season's growth. Terminal shoot buds are the next to develop. Buds on short spurs and lateral buds are last.

LABORATORY EXERCISE

Activity:
Demonstration of the process of osmosis

Materials:
1 slice of an Irish potato
1 tablespoon of salt
2 glasses of water

Procedure:

1. The tablespoon of salt is dissolved in one of the glasses of water.

2. The slice of Irish potato is placed in the glass of salty water and is left in the glass for fifteen to twenty minutes.

3. The slice of potato is examined. It should be soft and flabby. Some of the water in the cells of the potato has moved from the area of concentration to the less concentrated salt solution. At the same time, salt molecules are moving into the cells of the slice of potato. However, it will move at a very slow rate because the membrane of the cells is not permeable to salt.

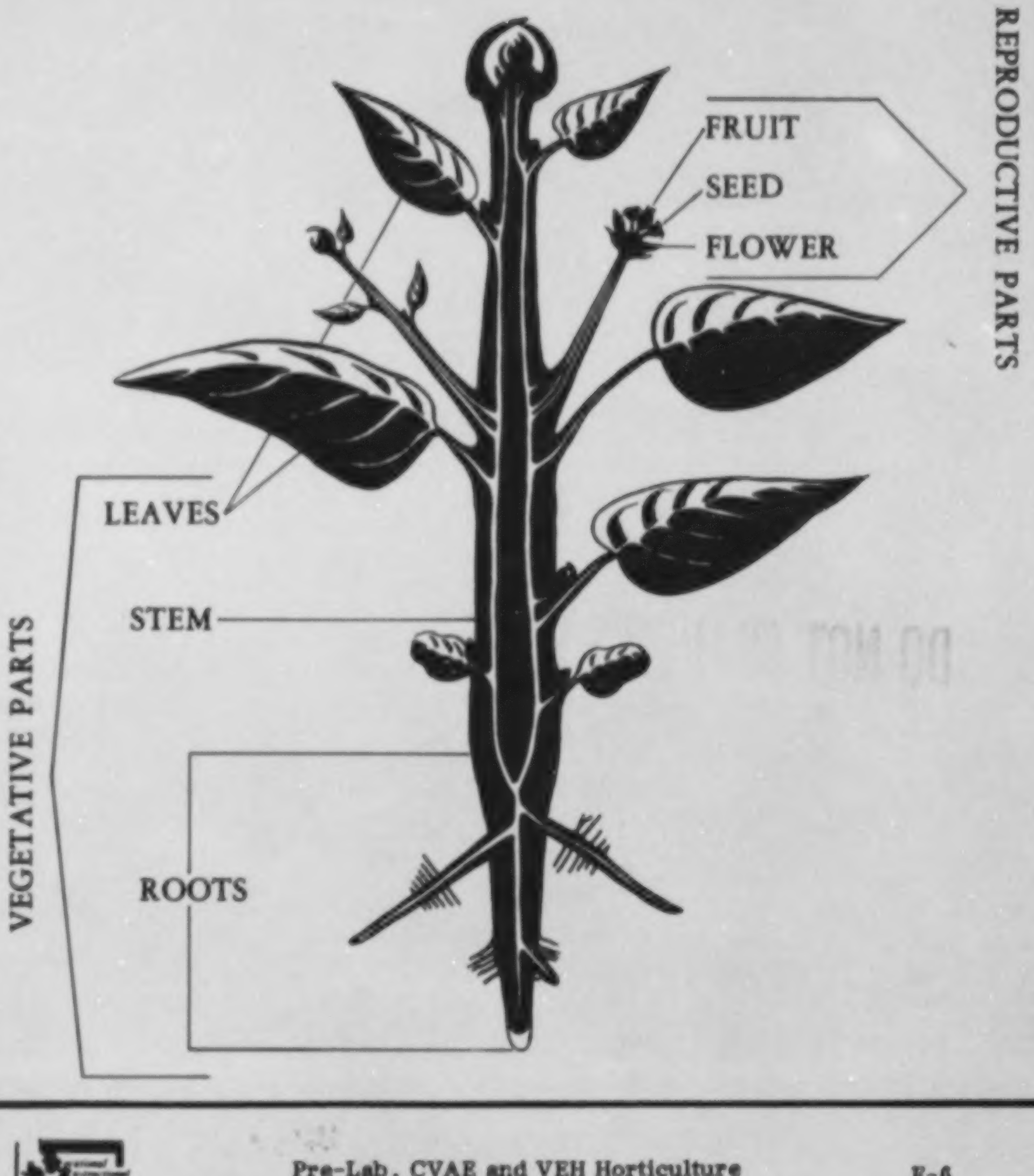
4. Place the same slice of potato in the other glass of water. It will regain its firmness.

The movement of a substance from an area of greater concentration to an area of less concentration has been demonstrated.

Reference:

Bailey, Leo L., A Step-By-Step Guide to Landscaping and Gardening, Exposition Press, Hicksville, New York, 1974.

PARTS OF A PLANT


REPRODUCTIVE PARTS
FRUIT
SEED
FLOWER
LEAVES
STEM
ROOTS
VEGETATIVE PARTS

CVAE AND VEH HORTICULTURE

Unit F: Propagation of Plants

Topic 1: Sexual Propagation of Greenhouse, Ornamental, and Nursery Plants

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedure and Activities:

Students should be given the opportunity to handle and observe the different kinds of containers used in sowing seeds inside the greenhouse.

The teacher's attention is directed to the laboratory exercise at the end of the topic.

1. Introduction

Many of the seeds used today were originally produced by wild plants which had very low yields. Through thousands of years of breeding, propagation, and cultivation these seeds are now producing very high yielding plants. An example is the sweet potato. It was once a wild plant very similar to the morning glory, a troublesome weed in field crops.

There are two distinct methods of propagating plants. These are (1) sexual (the seed or natural method) and (2) asexual (vegetative method). Asexual propagation is the reproduction of plants by using the vegetative parts of a plant, such as a part of the stem, root, or leaf. Both methods offer advantages and disadvantages. Most vegetable and field crops and propagated from seeds, while most deciduous fruit trees, commercial nut trees, grapes, small fruits, and ornamental shrubs are propagated asexually.

2. Parts of Seed

Transparency No. 1

The three basic parts of a seed are the seed coat (testa), embryo, and storage tissue (cotyledons or endosperm). The seed coat is usually made up of two layers. The outer seed coat is usually dry, thickened, and hardened; while the inner coat is thin and transparent.

Seed coats protect the embryo from mechanical injury, excessive moisture losses, and other unfavorable conditions. The seed coat makes it possible to handle seeds without injury and permits transporting and storage.

The embryo is a miniature plant within a seed. It contains the leaf, stem, and root tissues. Each end of the embryo has a growing point. One point produces the shoot, while the other produces roots. Also contained in the embryo is one or more seed leaves (cotyledons). The seed leaf or leaves are the first leaves to appear when the seed germinates.

Nature has provided an area inside seeds for the storage of food (food storage tissue). This provides the embryo with food. While seeds are held in storage it appears that the embryo uses food constantly but on a very low level while in storage.

Four types of storage tissues are found in different seeds, but the two most common are cotyledons and endosperm. Cotyledons serve as storage tissue in beans, while endosperm is the storage tissue in corn.

To help students remember the three parts of a seed it might be compared to an orange. The peeling is the seed coat providing protection for the embryo. The fruit or meat is the food storage tissue and the embryo is the seed, the part that produces a new plant.

3. Seed Formation

Plants reproduce sexually much in the same manner as animals. The plant flower forms the seeds and is the organ where reproduction takes place. To understand the process, students should be able to identify the parts of the flower and their function.

Transparency No. 2

The flower begins as a bud at the top of a special stem. As one observes a flower bud, the calyx is usually what is seen. The calyx is made up of several sepals. Sepals cover and protect the parts of the flower until it is ready to open or bloom. The sepals are often green in color.

Toward the center of the flower are the petals, which are either white or colored. The color of petals usually attract attention. Red petals of a rose are an example.

On the left side of the transparency is the stamen, the male part of the flower. It is made up of a long stalk called the filament. On one end of the filament is the anther, which contains the pollen grains.

The female part of the flower is called the pistil. It is made up of the stigma, style, and ovary. The stigma is often sticky so that it can receive pollen. The style is a tube-like structure through which the male germ (pollen grains) travels to fertilize the egg. The ovary is a rounded compartment which contains the eggs waiting to be fertilized.

A flower having all three parts is referred to as a perfect flower. Perfect flowers are produced by apple, grape, strawberry, tomato, cabbage, cotton, bean, and citrus fruit plants.

Flowers lacking female parts are male flowers, and flowers lacking male parts are female flowers. Some plants, such as pecan, corn, cucumber, squash, and watermelon, have both male and female flowers on the same plant. Some plants produce a female flower on one plant and male flower on another. Holly, persimmon, spinach, and asparagus are plants of this type.

4. The Process of Sexual Reproduction

Before the ovules(egg cells) in the ovary can develop into seeds, they must be fertilized with pollen. By the time the pistil is ready to be fertilized in most plants, the anther opens; and the pollen is released. Transfer of pollen from the anther to the stigma is called pollination. If the pollen is transferred from the anther to the stigma of the same flower, or to any other flower on the same plant, the flowers are self-pollinated. Oats, barley, field peas, tomatoes, and wheat are self-pollinated plants. If pollen from the anther of the flower on one plant is transferred to the stigma of the flower of another plant, the flowers are cross-pollinated. American holly, white clover, and red clover are examples of cross-pollinated plants.

The seeds of self-pollinated plants will remain and breed true for some time. The seeds can be used for planting a new crop, and the new crop will be identical to the original crop.

Seeds from cross-pollinated plants can be used only one year. After the first year, there is a loss in size, yielding ability, and plant vigor.

Pollination of Plants

The pollen either falls from the force of gravity or is carried by wind or insects from the anther to the stigma to pollinate plants. Some plants are sterile to their own pollen and must be cross-pollinated. Many of these plants have showy petals and fragrant odors which attract insects. Bees and other insects enter the flower to get pollen and nectar. Their hairy bodies collect pollen from the anthers; and when they visit other flowers, pollen brushes off on the stigma. Cross-pollination is achieved.

Transparency No. 3

Once the pollen grain reaches the stigma, it germinates and sends a pollen tube down the style and into the ovary. Male sperm cells that have been formed in the pollen grain move down the pollen tube, and one of the sperm cells enters the ovule or egg. When this happens, fertilization has taken place. Cell division then takes place and the embryo (new developing plant) is formed. The ovule (embryo and forming seed) is attached to a placenta. It is through the placenta(just like in animals) that the developing seed and embryo receive food for growth from the mother plant.

5. Factors Affecting the Viability of Seeds

A number of factors affect the germination of seeds. A discussion of some of these factors is as follows:

Transparency No. 4

Damaged seeds - Seeds that have been damaged by insects, rodents, and heat or that have a broken seed coat will not germinate properly; and they may not germinate at all.

Old seeds - Many plant seeds will not remain viable much longer than one year. This is especially true of horticultural plants.

Soil or media too wet - After the initial watering, further watering is usually not needed; however, if the top of the media dries out, it may need to be watered lightly.

Temperature too cold - Where soil and air temperature are too cold, the seed uses all of its stored food before it can manufacture food. Too cold a temperature also prevents the absorption of moisture needed for germination. The optimum temperature for most germinating seeds is 70° F.

Hard seed - The seed coats on some seeds are so hard and tough that moisture cannot enter the seeds. With seeds of this type, it is necessary to scarify them (a process to weaken the seed coat to allow the absorption of moisture to begin the process of germination). The three methods of scarifying seeds are the sulphuric acid treatment, hot or boiling water treatment, and mechanical scarification.

Disease - Seed treatment and sterilization of the media will control most diseases affecting seeds and seedlings caused by bacteria and fungi, which may be carried by air, water, and insects. Damping-off is probably the most prevalent disease affecting young plants. It may be controlled by sterilizing the media.

Drying out of media - The media should be kept moist enough to encourage germination but not so damp as to encourage damping-off or to prevent aeration.

Planting too deep - Seeds planted too deep use all of their stored plant food before surfacing to die. A good rule to follow in planting seeds is to plant them no deeper than three times their diameter. Using this rule, a person would cover small seeds with one-eighth to one-fourth inch of media.

Dormancy or rest period - A dormant embryo is the most common cause of a natural delay in seed germination. Seeds must complete their rest period(ripening period) before they will germinate. During this period, the seeds require an abundant supply of oxygen and moisture and the proper temperature. For most native shrubs, trees, and ornamental plants, an average temperature of 41° F. is favorable.

The rest period for some plant seeds can be shortened by stratification, a process whereby the seeds are placed in a moist media and held at a temperature of about 35° F. for one to six months, depending on the species. General recommendations as to length of stratification for various species of seeds are given at the end of the topic.

6. Sowing Seeds

To allow for seeds that will not germinate and for weak seedlings which should not be transplanted, the grower should sow more seeds than the number of plants he expects to produce. Where modern seed germination methods are used, a 65% germination rate is about average. To prevent disappointment, a delay in time, and possibly a loss of money, the grower should conduct a germination test if the germination percentage is not known.

The seed packets usually contain the germination percentage, date seeds were produced, last date for successful planting and germination, percent of inert materials in the packet, purity of seeds, and whether weed seeds are present. The grower should read the information on the seed packet and follow the manufacturer's recommendations.

Sowing Seeds Outdoors

When woody deciduous plants begin to leaf, seeds can usually be sown outdoors without the danger of being killed by cold weather. A few more seeds should be sown outdoors than would be sown in the greenhouse. They may be either planted in rows or broadcast. The grower may wish to plant very small seeds in a container and transplant them as seedlings.

Flower seeds are usually sown in rows about eight inches apart and from one-eighth to one-fourth inch apart within the row. The seeds should be covered with screened soil or peat moss and the beds firmed and watered. A mist nozzle is used for watering to prevent washing the seeds out of the media.

Sowing Seeds in the Greenhouse

There are several advantages in starting plants in a greenhouse. This is the best method of propagating very small and expensive seeds, seeds that require a long time to germinate and grow, pot plants or bench plants, large plants for summer production, and plants one wants to start before the weather outside is favorable.

Several different kinds of containers are used in the greenhouse for sowing seeds; however, pots, flats, and market packets are probably the most commonly used containers. Pots are available in several shapes and sizes and are constructed of several different types of material. Flats vary in width from six to twenty-four inches, are lightweight, and are usually made of wood. The flats are small, easy to handle, and help keep growing crops on schedule. Several different kinds of market packets are available. They may be made of plastic, peat moss, or fibrous materials. The pack may or may not contain a soluble fertilizer. The advantages offered by using the market pack are that the roots are not disturbed when transplanting, the plant does not suffer from the shock of transplanting, and a minimum of labor is required to market. Instead of planting seeds in containers, some growers sow seeds directly in the media in benches. This is particularly true of cut-flower producers.

Certain precautions should be taken when sowing seeds. The grower should mix the fertilizer evenly throughout the media, and the media should be thoroughly watered. The propagating containers should be filled to the top edge with the media and firmed lightly. If small seeds are sown, a peat-perlite mixture or sphagnum moss should be screened on the surface to a depth of 1/16 inch to cover the seeds; but it may not be necessary to cover very small seeds.

Transparency No. 5

Since most growers of greenhouse plants use flats in the production of plants, a discussion of the several factors that one should consider in sowing seeds in flats is given.

1. Medium - The germination medium should be fine textured and must have good contact with the seeds. A brick or board can be used to firm the media. If vermiculite or a similar material is used, it should not be firmed because it will lose air space and water holding capacity.
2. Spacing of seeds - The seeds may either be broadcast or planted in rows. If planted in rows, each seed should touch the adjacent seeds. The rows should be spaced one and one-half inches apart. Very small seeds may be mixed with a small amount of soil to help distribute them evenly when planting.
3. Seed covering - The seeds should be planted at a depth that will allow an easy emergence.
4. Watering - After the seeds are sown and covered with media, they should be watered. The flat may be watered with a fine mist nozzle, sub-surface irrigation, or by placing a burlap bag over the flat and soaking the flat thoroughly. After the initial watering, generally no additional water is needed. Some growers place the entire flat in a plastic bag to retain moisture until germination occurs.

5. Aeration - An adequate supply of oxygen must be available for the seedlings. This will help prevent damping-off and help produce sturdy, strong plants.
6. Labeling the flats - All flats should be labeled with the following information: name and variety of plants, date seeded, and special treatment. Pot labels may be used for labeling flats; but the bottom one-third of the label should not be written on since it will be inserted in the media.

Caring for the Seedlings

Caring for the Seedlings - In order for seedlings to develop properly, favorable conditions must be provided during the critical growing period. After the seeds are sown and before the seedlings are transplanted, the grower should control diseases and insects and provide environmental conditions that will produce healthy, vigorous plants. The following factors will influence germination and growth of the seedlings:

1. Watering - The moisture supply should be constant but not excessive. The seed bed should be watered only enough to prevent the top of the media from drying out. After the seedlings have emerged from the soil, they should be watered frequently until a good root system has been developed. As the root system develops, less watering is required.

2. Controlling Temperature and Light - Adequate light should be provided for the seedlings to prevent the production of long, spindly plants. However, full sunlight may not be needed in the early stages of plant growth. If too much heat is associated with light, it may be necessary to place the plants in partial shade.

   The most important factor in controlling heat is to maintain the temperature as nearly constant as possible. Drastic changes in temperature cause growing plants to develop slowly and poorly. The general recommendation for cool season plants is a daytime temperature of 60° F. and 45° to 50° at night, while for warm season plants 70° temperatures are recommended during the day and a 10° to 15° drop during the night. Since different plants require different growing temperatures, propagator should follow the recommendations for a particular plant.

3. Disease - Most diseases affecting seedlings are present either in the soil or on the seeds at planting time. The best method of disease control is prevention, which in most cases can be accomplished by treating the seeds and sterilizing the media. Many seed-borne diseases can be controlled by treating the seeds with Arasan, Semesan, or Spergon. If seeds are used from a packet, many times the packet can be opened and a small amount of the commercial product placed in the packet with the seeds and the contents shaken until the seeds are coated with the chemical.

If it is impractical to sterilize the soil, new soil should be used.

4. Thinning - This may not always be a factor; but if the seedlings are going to be left in place until they are sold, they may need to be thinned. The seedlings removed by thinning may be planted elsewhere. Properly thinned seedlings produce healthier plants.

Transplanting Seedlings

The seedlings soon become overcrowded and their growth retarded if they are not transplanted. The proper time to transplant the seedlings is as soon as the first true leaves appear and the plant is large enough to handle.

Often plants need to be hardened before transplanting. The environmental conditions of the plant are gradually changed to the conditions similar to those in which they will be growing in order to harden them. Prior to transplanting, the seedlings should be watered well and the soil allowed to dry enough to prevent caking of the soil when handled.

Transparency No. 6

The transplanting operation causes a plant to discontinue its growth. Every effort should be made to limit the amount of shock for the transplanted seedling. To avoid damage to the plant when transplanting, the grower should hold the seedling between the thumb and forefinger by the leaf rather than by the stem. The roots of the seedling should be exposed to the air a minimum length of time. A small stick or other instrument may be used to lift the seedling from the starting container to the larger container or bed.

There are two kinds of seedlings. One has an upright stem (Type 1) with the growing point at the tip. The other type of seedling (Type 2) forms a rosette and has its growing point at the base of a cluster of leaves. It is important to know the difference between the two because the type affects the depth at which they can be transplanted. The type with the growing point at the top of the stem can be planted to a depth just below the leaves, while a rosette seedling must be planted to a depth as it was in the seed container. If the rosette is planted deeper, the seedling may die because the growing points are covered. The soil around the seedling should be firmed after it is transplanted. Also, the seedling should be watered.

As the seedlings are transplanted, they should be graded according to size. Large seedlings should be placed in one container, and the smaller placed in another. Weak, slow growing seedlings should be discarded. Grading the seedlings according to size allows the plants in a container to be of uniform height and vigor and makes them more attractive to the buyer.

The first few days after transplanting, the seedlings should be shaded. This will reduce the rate of transpiration and slow growth until new roots are formed to replace those lost in transplanting. After becoming established, the plants should be given full sun, adequate moisture, nutrients, and a temperature of about 60° F. If the plants are to be placed outside, they should be hardened. Pot or bench plants that will be kept in the greenhouse should be kept at the same temperature. Since different plants require different temperatures, it is important that the grower know the proper forcing temperature for the plants he is growing.

Transplanting Plants Outside

A fast growing plant has relatively soft tissue and is more susceptible to wind, cold, and drought conditions. The young plant also has a very small reserve of food to replace the absorbing roots normally lost in transplanting. The success of transplanting from inside to outside is dependent upon the care and handling of the plants before moving them.

The final preparation before transplanting is the hardening-off process (a process of preparing plants to withstand cooler temperatures). This process increases the possibility of the plant becoming established. The best way to harden-off plants is to change the controlled environmental conditions from the favorable inside conditions to the conditions found outdoors. This is accomplished by gradually reducing the water supply and the temperature. This slows vegetative growth and tends to result in firmer tissue. It also lowers the rate of transpiration, gives the plants greater resistance to cold temperature, and allows for the accumulation of manufactured food to support the rapid development of new roots.

To help reduce the shock of transplanting, some growers root prune those plants that respond to root pruning. A sharp knife is drawn between the rows of plants in the flat similar to cutting a cake. This causes the plant to develop new feeder roots. Root pruning should be done about ten days before the plant are transplanted. The grower should be sure that the plants respond to root pruning before performing this operation.

LABORATORY EXERCISE NO. 1

Activity:

Determine the number of seeds to plant if 300 dozen plants are needed for a spring sale when the trade packet gives the germination rate at 60%.

Materials:

None needed

Procedure:

1. Determine number of seeds to plant.
    a. 300 x 12 = 3,600 = number of plants needed
    b. 3600/.60 = 6,000 = number of seed to plant

LABORATORY EXERCISE NO. 2

Activity:
Seed Germination Test

Materials:
Seeds
Paper or cloth towel
String or tie material

Procedure:
1. Select 100 seeds at random from the lot.
2. Place the seeds on the paper or cloth towel.
3. Place a towel on top of the seeds and roll towels and seeds into a roll.
4. Tie rolled towels and dampen.
5. Keep towels moist and warm for several days.
6. Open the towel and count the germinated seeds.

$$\text{Germination percentage} = \frac{\text{No. of seeds germinated}}{\text{No. of seeds placed on towel}} \times 100$$

(Seeds can also be tested by seed testing laboratory.)

LABORATORY EXERCISE NO. 3

Activity:
Prepare and seed a flat

Materials:
Flats
Perlite-peat mixture, 50/50 by volume
Seeds (Large, medium, and small; a flat of each should be seeded.)
Plant labels
Cellophane bags (used to place flat in and retain moisture)
Soil sterilant --if needed
Vibrator seeder
Screening box
Vat (used to subirrigate flats)
Spray nozzle

Procedure:
1. Fill flat full of the perlite-peat mixture and firm lightly to about 1/4 inch from top of flat.
2. Screen perlite-peat mixture even with the top of the flat.
3. If soil needs to be sterilized, a soil sterilant should be used. The flat can be subirrigated with the sterilant.
4. After water and sterilant have drained from the flat, seeds are ready to be planted. Only one variety should be planted in a flat.

5. After covering seeds, the flat should be watered with a fine spray.
6. The flat is labeled.
7. The flat is placed in the cellophane bag, and the bag is sealed.

LABORATORY EXERCISE NO. 4

Activity:
Demonstrate the handling and transplanting of seedlings

Materials:
Potting media
Pots or containers
Soluble fertilizer
Watering equipment
Instruments for removing seedlings

Procedure:
1. Thoroughly water flats a few hours before the plants are to be removed.
2. Select containers and fill with media. Firm the media lightly.
3. Sterilize media if it needs to be sterilized.
4. Use dibble to make holes in medium that will receive seedlings.
5. Carefully lift a seedling from flat and place in new container.
6. Press the media firmly around the roots of the seedling.
7. Water the seedling and label it.

LABORATORY EXERCISE NO. 5

Demonstrate the scarification of seed. Three different methods are given. Each method is numbered.

Activities:
1. Sulphuric acid treatment
2. Hot water treatment
3. Mechanical scarification

Materials:
Seed (Redbud, Silktree albizzia)
1. Glazed container; commercial grade of sulphuric acid
2. Container; source of heat
3. Mechanical scarifier

Procedure:
1. Sulphuric acid treatment
   a. Seeds are placed in a glazed pottery container.
   b. Sulphuric acid is poured into the container, covering the seeds.

   c. Seeds are stirred periodically so that the coats of floating seeds will be covered.
   d. Seeds are allowed to soak for the proper length of time (redbud, 20 minutes; silktree, 15 to 30 minutes).
   e. Acid is drained from the seeds.
   f. Seeds are washed for 10 minutes in running water, and then are allowed to soak in water for several hours before sowing.

2. Hot water treatment
   a. Water is heated to 200° F.
   b. Water is removed from source of heat.
   c. Seeds are placed in water, and seeds and water are allowed to cool. (Another method is to place the seeds in a cloth or muslin bag and dip the bag into boiling water for 30 seconds to two minutes. If the seeds are not handled properly with this method, they will be damaged or killed.)
3. Mechanical scarification
   a. Seeds are placed in unit.
   b. The unit is operated long enough to sufficiently scratch the seed coats. (Another method is to scratch or nick each seed with a sharp object.)

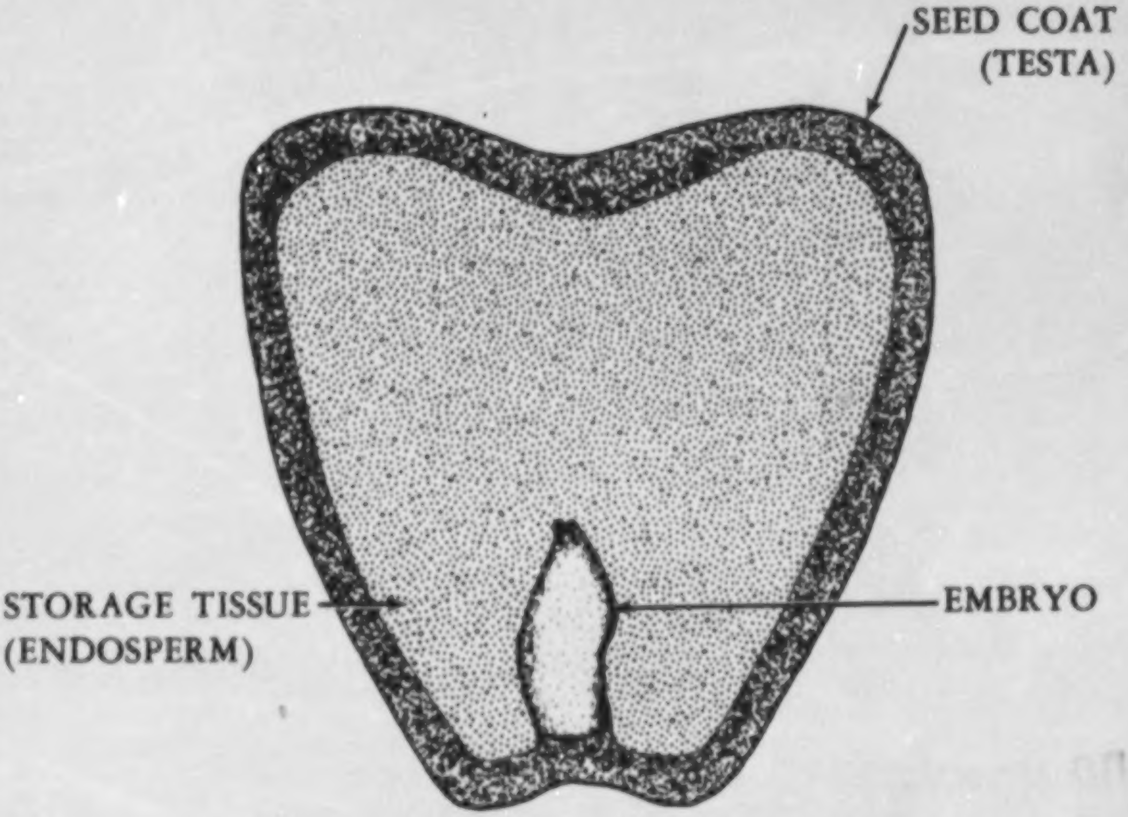
References:

1. Hartmann, H. T, and Dale E. Kester, Plant Propogation Principles and Practices, Prentice-Hall, Inc., Englewood Cliffs, New Jersey, 1968.

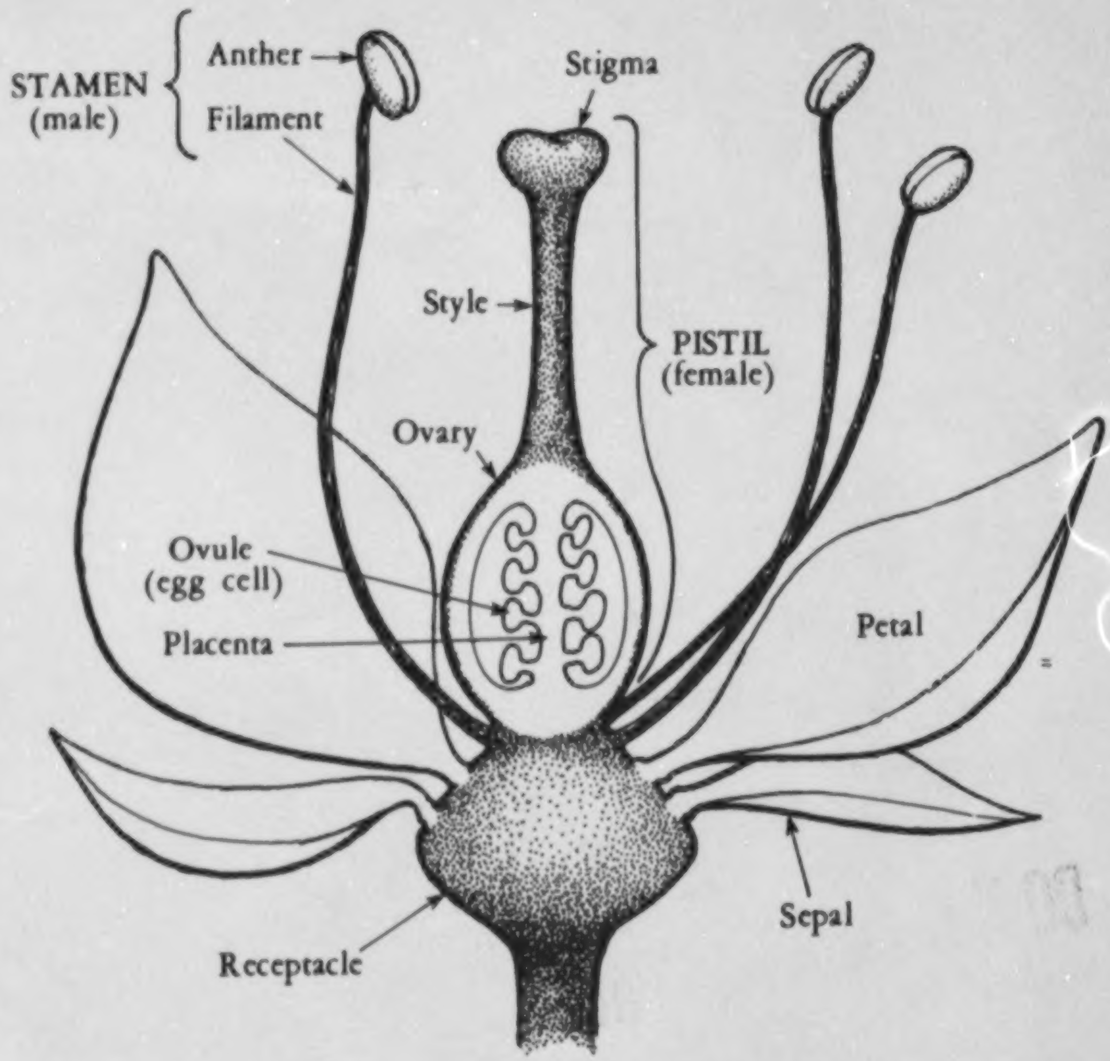
2. Bailey, Leo L., A Step-By-Step Guide to Landscaping and Gardening, Exposition Press, Hicksville, New York, 1974.

PARTS OF SEED

CORN

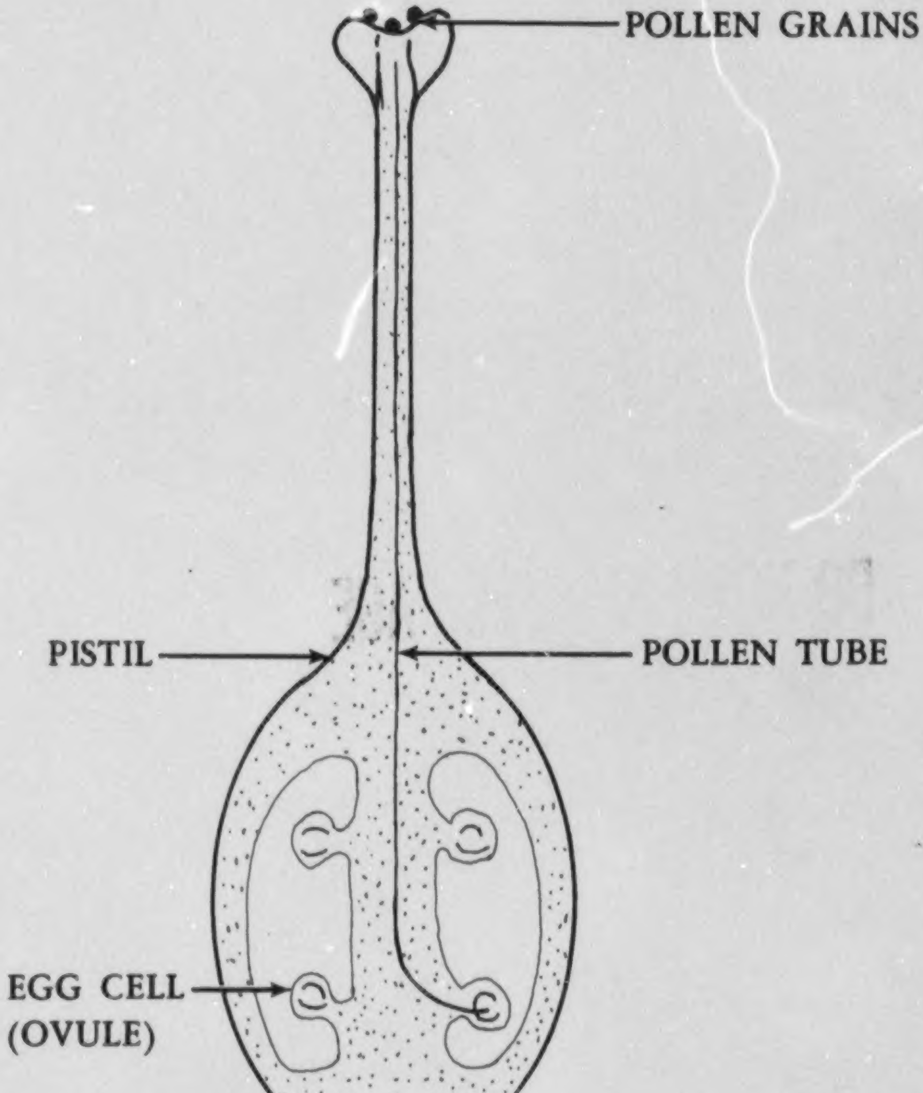

SEED COAT
(TESTA)
STORAGE TISSUE
(ENDOSPERM)
EMBRYO

PARTS of a FLOWER


STAMEN
(male)
Anther
Filament
Stigma
Style
PISTIL
(female)
Ovary
Ovule
(egg cell)
Placenta
Petal
Sepal
Receptacle

FEMALE PARTS OF A FLOWER

GROWTH OF POLLEN TUBES AFTER POLLINATION


POLLEN GRAINS
PISTIL
POLLEN TUBE
EGG CELL
(OVULE)

FACTORS AFFECTING SEED GERMINATION

DAMAGED SEED

OLD SEED

SOIL OR MEDIA TOO WET

TEMPERATURE TOO COLD

HARD SEED

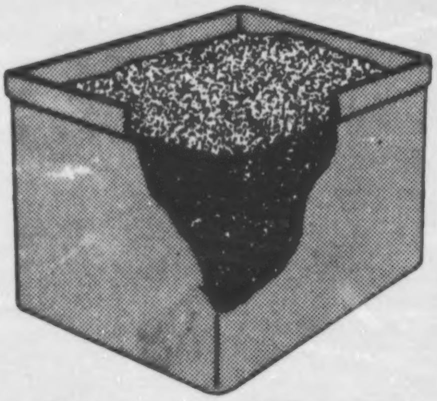
DISEASE

DRYING OUT OF MEDIA

PLANTING TOO DEEP

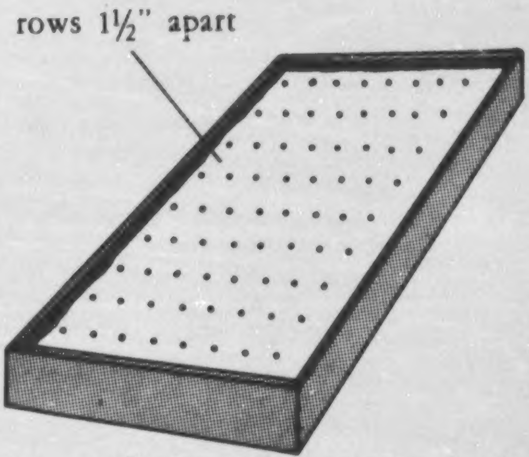
DORMANCY OR REST PERIOD

PLANTING SEEDS IN A CONTAINER



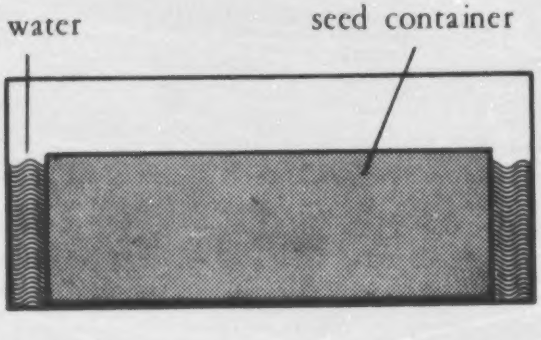
fill containers with fine textured medium

MEDIUM


rows 1½" apart

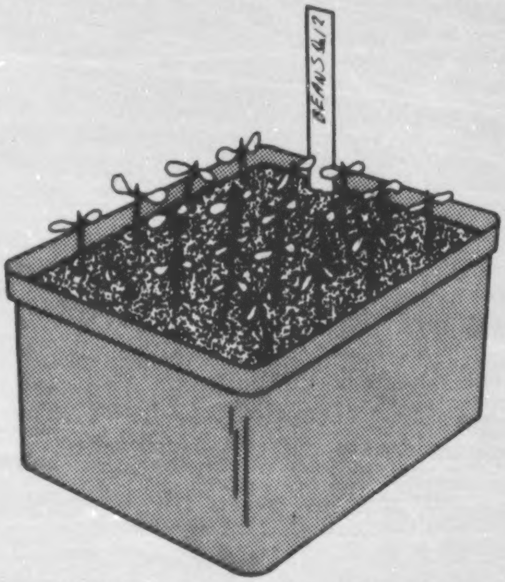
seeds covered to proper depth

SPACING OF SEEDS


water
seed container

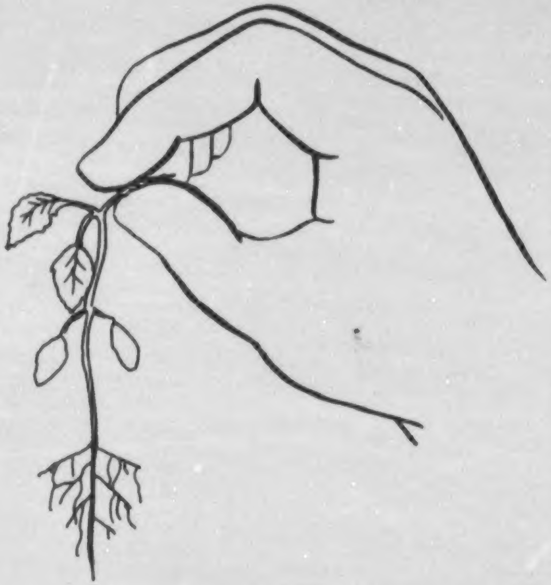
sub-irrigate or use mist nozzle

WATERING



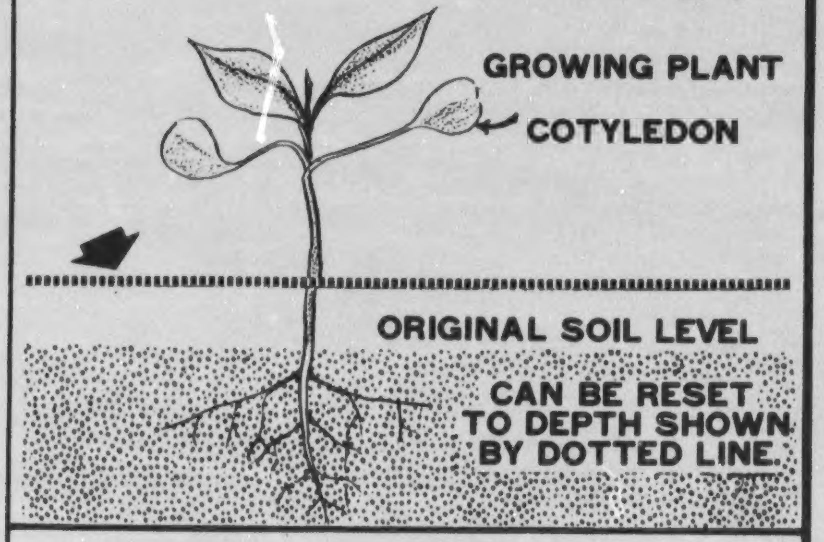
LABELING FLATS OR CONTAINERS

TRANSPLANTING SEEDLINGS



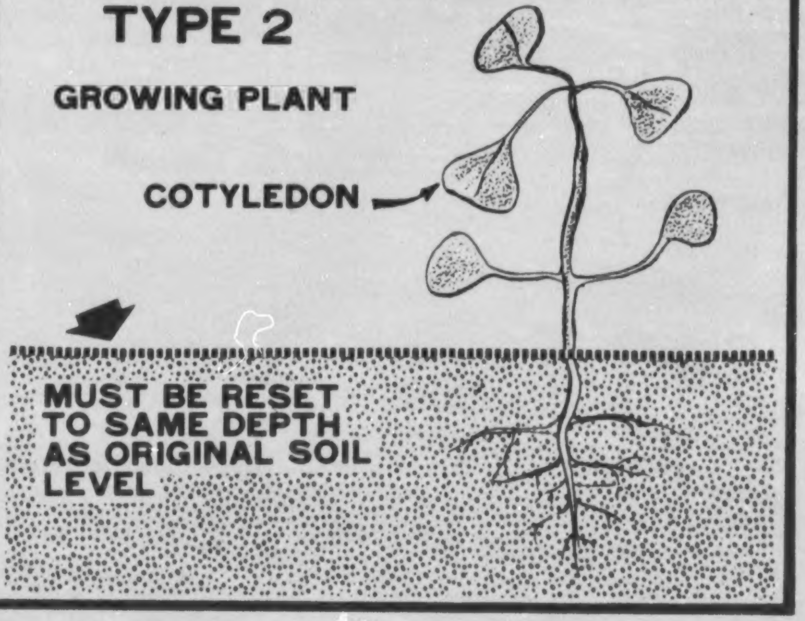
GRASP THE LEAVES OF TRANSPLANT AS SHOWN- NOT BY THE STEM

TYPE 1


GROWING PLANT
COTYLEDON
ORIGINAL SOIL LEVEL

CAN BE RESET TO DEPTH SHOWN BY DOTTED LINE.

TYPE 2


GROWING PLANT
COTYLEDON

MUST BE RESET TO SAME DEPTH AS ORIGINAL SOIL LEVEL

Vocational Instructional Services
Agricultural Education

F-2
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit F: Propagation of Plants

Topic 2: Asexual Propagation of Plants

Note: All terms underlined are included in the "Glossary of Terms".

1. Introduction:

Asexual propagation is the using of the vegetative parts of a plant to produce another plant. The vegetative parts of a plant used in asexual propagation are the roots, stems, and leaves. Many valuable plants do not produce seeds; therefore, they must be propagated asexually. The existence of many plants can be attributed to asexual propagation.

Transparency No. 1

Advantages of producing plants by asexual propagation are as follows:

1. Plants can be reproduced much faster;
2. Disease-free stocks can be produced;
3. Characteristics of a plant can be maintained; and
4. New plants can be produced exactly like the parent plant.

Some of the plants with which most people are familiar, that are reproduced by asexual propagation are seedless grapes, navel oranges, bananas, and most ornamental shrubs and trees.

2. Environmental Factors Affecting Asexual Propagation

Enviromental factors affect whether the reproduction of plants asexually is a success or failure. The four environmental factors that should be considered are temperature, moisture, oxygen, and light. Each is discussed.

Temperature - Both atmospheric and soil temperatures, referred to as top and bottom temperature, are important. As the temperature increases, photosynthesis and respiration increase. The recommended top temperature for the reproduction of plants is about 75°F. The soil temperature should be five to ten degrees warmer. Temperatures in these ranges will control photosynthesis and hasten root initiation.

Moisture - Soil moisture and humidity should be considered. Humidity is affected by the temperature. The warmer the air, the more humidity it will hold. A humidity between 60 and 80 percent is recommended for propagating plants. A higher humidity reduces transpiration, will cause the plant to wilt, and may cause the plant to rot. An automatically controlled intermittent mist system may be used to regulate the humidity. The mist forms a film on the plants and reduces water losses. The soil should be kept moist but not wet. Too much water in the soil will reduce the oxygen supply, which is necessary for root and leaf development.

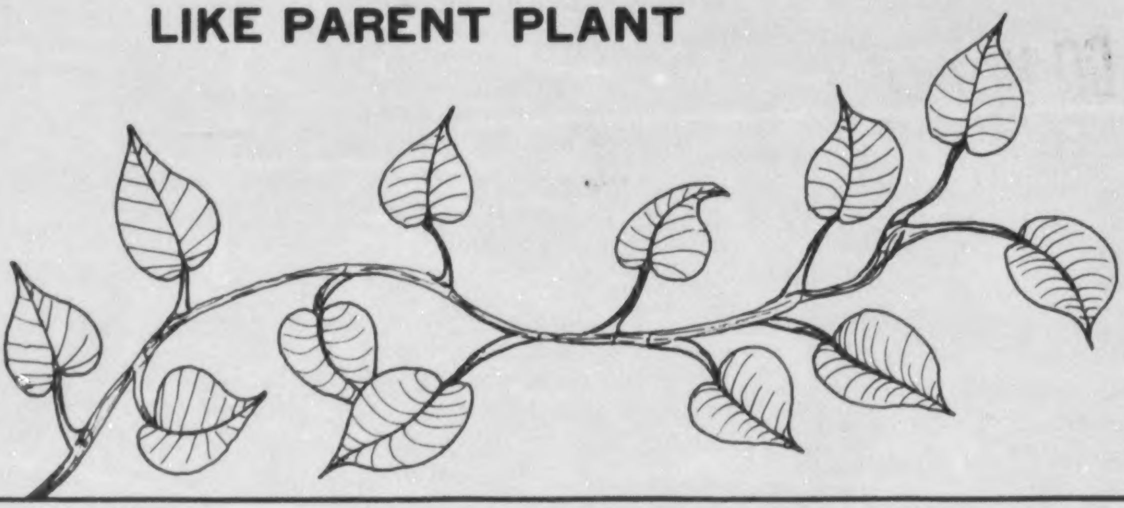
Light - Adequate light is necessary for plant growth; however, the plants should be protected from intense light. Light is measured in foot candles. On a clear summer day there are about 12,000 foot candles of light. The covering on the greenhouse will usually reduce the light intensity about 25%. Normally, the 9,000 foot candles reaching plants on a clear day would not be too much if a mist system is used. However, the propagator may wish to take a reading with a light meter to determine the exact amount of light intensity.

Reference:

Bailey, Leo L., A Step - By - Step Guide to Landscaping and Gardening, Exposition Press, Hicksville, New York, 1974.

ADVANTAGES OF ASEXUAL PROPAGATION

- PLANTS REPRODUCE MUCH FASTER
- DISEASE-FREE STOCK MAY BE PRODUCED
- CHARACTERISTICS OF A PLANT CAN BE MAINTAINED
- NEW PLANTS CAN BE PRODUCED EXACTLY LIKE PARENT PLANT



CVAE AND VEH HORTICULTURE

Unit F: Propagation of Plants

Topic 3: Propagating Plants From Cuttings

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Information included in this topic can be presented while conducting the laboratory exercises suggested at the end.

1. Introduction:

Any severed vegetative portion of a plant that may be used to produce a new plant is called a cutting. Horticulturists are able to produce plants from cuttings because some plants have cells which are capable of forming the type of tissue needed by new plants. After the cells have formed tissue in the new plant, they develop into the cells needed by the plant.

2. Propagating Plants From Stem Cuttings

There are three kinds of stem cuttings. They are (1) softwood, (2) semi-hardwood, and (3) hardwood. These terms refer to the hardness of the stem at the time the cutting is made.

Softwood cuttings are used for the propagation of deciduous or evergreen shrubs, trees, climbing plants, and herbaceous perennials. Cuttings from these kinds of plants can be taken any time during their active growing season, which is usually in the spring or early summer. The best time to take cuttings is after the first flush of growth in the spring. The wood from this growth is excellent for cuttings.

Semi-hardwood cuttings are those taken from evergreens. The best time to make these is during the summer or in the autumn. They should be selected at the point on the stem where the growth is firm enough to snap when the twig is bent sharply. If the wood bends and does not readily snap off, it is too old to root as a semi-hardwood cutting.

Hardwood cuttings may require as much as a year to become established. The propagator using this type of cutting must have a lot of patience. Root production can be promoted in some hardwood cuttings by wounding the base of the cutting. This is accomplished by making several one - to two - inch cuts with a sharp knife through the bark on the basal end.

The chances for success when making stem cuttings can be increased by following the recommendations below:

1. Cuttings selected from younger plants develop more rapidly;
2. Cuttings taken from the lower portion of the parent plant root more readily;
3. Side branches that develop after a plant has been pruned develop faster;
4. Cuttings should be taken early in the morning; and
5. Cuttings should be taken from healthy, rapid growing stems.

Transparency No. 1

The procedure for making stem cuttings is as follows:

1. Select stems that are about 1/2 inch in diameter and that have at least two nodes.
2. Stems are cut 3 to 6 inches long, with the basal cut made just below a node and on a slant.
3. The bottom leaves are trimmed from the cuttings. Leaves should not be allowed to touch the rooting media. If there is not sufficient space in the propagation bench, some of the upper leaves may be removed.
4. Cuttings are treated with a root promoting hormone. Coleus, succulents, and geraniums do not require a hormone treatment.
5. Cuttings are placed in an upright position in media.
6. Media is firmed around cuttings. Bottoms of cuttings should be in contact with media.
7. Cuttings should be kept moist, and the atmospheric temperature is maintained at 70° F. The soil temperature is maintained from 5 to 10 degrees warmer.

A brief explanation is geven for making hardwood cuttings, since various methods are used for making these:

1. Deciduous cuttings are selected, bundled, and labeled. The cuttings are placed in a trench and covered with about 3 inches of soil. They are allowed to remain in the trench until spring, when they are placed in propagation benches.

2. Cuttings are selected in the fall, cut, and bundled with the tops all in one direction. The bundles are placed in moist peat moss and stored at about 37° F. in a refrigerator until spring. They should not be allowed to freeze.

3. The cuttings are selected in the fall, put in bundles, labeled, and stored in moist peat at about 70° F. for 3 to 5 weeks to stimulate root initiation. Then they are stored in a refrigerator at about 37° F. until placed in the propagating bench in the spring.

3. Producing Plants From Leaf - Bud Cuttings

Leaf-bud cuttings are an ideal method of propagating plants because there are more stored food materials and hormones in the plant tissue near the bud, and a large number of plants can be propagated from a small amount of stock. Each node on the stem can be used as a cutting.

Transparency No. 2

Leaf-bud cuttings are taken in the spring from rapid growing non-woody shoots. The cutting is made by taking a bud that has a single leaf attached and placing the cut stem and the bud in the propagation media. The leaf may either lie upon the media or be placed upright.

4. Producing Plants From Leaf Cuttings

A new plant is produced from leaf cuttings because cells in the leaf produce a root and shoot system. There are two kinds of cells from which the system develops. They are called primary and secondary meristem. Meristem is a group of cells which are capable of producing permanent tissue. The root and shoot system is usually produced from secondary meristem, but both kinds are discussed.

Transparency No. 3

Shoot and root systems developing from primary meristem originate from foliar embryos located along the leaf margin. Actually these are small plants living on the leaf margin. The embryo is dormant until the leaf is detached and placed in the media and proper environment. After the leaf is placed in the media, the embryo develops. The small plant sets its root and becomes independent of the leaf.

Transparency No. 4

Plants developing from secondary meristem are produced from cells which were a part of the tissue of the mature plant.

Transparency No. 5

Leaf cuttings may be made in the following ways: (1) leaf blade, (2) leaf blade and petiole, (3) cutting the leaf into triangular sections and using the sections, and (4) cutting several veins in the leaf and pinning the leaf to the media. The latter method should be used when cuttings are made from broad, thick leaves. The petiole cutting is made by inserting the petiole into the media up near the leaf, or by inserting the petiole and the base of the leaf into the media.

5. Producing Plants From Root Cuttings

Root cuttings can be taken from any plant that produces sprouts from the roots or from plants that develop stems from roots. The bud is not visible on the roots, but will develop after they are placed in the media.

Transparency No. 6

To make root cuttings soil is dug from around the roots of the parent plant. The proper size root is selected, cut into pieces about 3 inches long, and placed into a flat or box which has been filled with media. Cuttings are placed in a horizontal position about 2 inches apart in the box and covered with about 1 1/2 inches of media. The media is then watered.

Another method that may be used in making root cuttings is to drive a sharp spade into the ground around the plant and cut the roots. New plants will eventually emerge from the ground. The new plants are dug and transplanted after one season's growth.

6. Using Growth Regulators

Growth regulators have many uses in the growing of horticultural plants. They may be used to encourage rooting; increase flower, fruit, and plant sizes; control weeds; retard growth; and encourage the setting of fruit.

Growth regulators are available in several forms and are manufactured by several commercial firms. The dry form is most often used as a rooting compound. Other forms (sprays, paste, vapor, and concentrated solutions) are generally used for other purposes. Even though regulators are very helpful in propagating plants, the grower should be aware that they will not replace proper environmental conditions or proper propagating methods.

Some plants do not respond to rooting compounds, and each variety and specie responds differently. Plants that are known to respond to treatment are camellia, carnation, chrysanthemum, coleus, English ivy, eounymus forsythia, impatiens, philodendron, poinsettia, and rose. The more difficult plants to propagate that respond to treatment are azalea, barberry, currant, dogwood, holly, honeysuckle, hydrangea, juniper, magnolia, privet, quince, and yew.

The step-by-step procedure for using the powdered form for the stimulation of root growth in cuttings is given below:

Transparency No. 7

1. The powder is placed in a salt shaker.
2. A small amount of regulator is shaken onto a sheet of paper.
3. The basal end of the cutting is dipped into one-half to one-inch of water.
4. The moist end of the cutting is stuck in the powder. Excess powder is removed by blowing it off. When the paper containing the powder gets too wet it is replaced with a dry sheet.
5. The basal end of the cutting is placed end to end and one-half inch below the surface of the rooting medium.

Two types of liquid regulators are also used to stimulate root growth of cuttings. The basal end of the cutting is dipped in one type, while the cuttings are soaked in the other for a period of 24 hours.

LABORATORY EXERCISE

Activity:

1. Demonstration of the procedure for making stem cuttings (softwood, semi-hardwood, and hardwood), leaf-bud cuttings, and root cuttings (both methods)
2. Demonstrate the use of three different types of growth regulators.

Materials:

1. For making cuttings.
   - Parent plants for each different kind of cutting
   - Propagating bench and media
   - Box and media for making root cuttings
   - Spade (sharp shooter) for making one kind of root cutting
   - Plant labels
   - Plastic bags
2. For demonstrating the use of growth regulators
   - Powdered form of growth regulator
   - Two types of liquid growth regulators
   - Cuttings

Procedure:

Since the procedures for making each kind of cutting and using growth regulators are explained in the topic, they are not repeated in the laboratory exercise.

REFERENCES:

1. "The Propagation of Ornamental Plants," Texas Agricultural Experiment Station, B-1093, 1970.

2. "Propagating Horticulture Plants," Vocational Instructional Services, Texas A&M University, 1969.

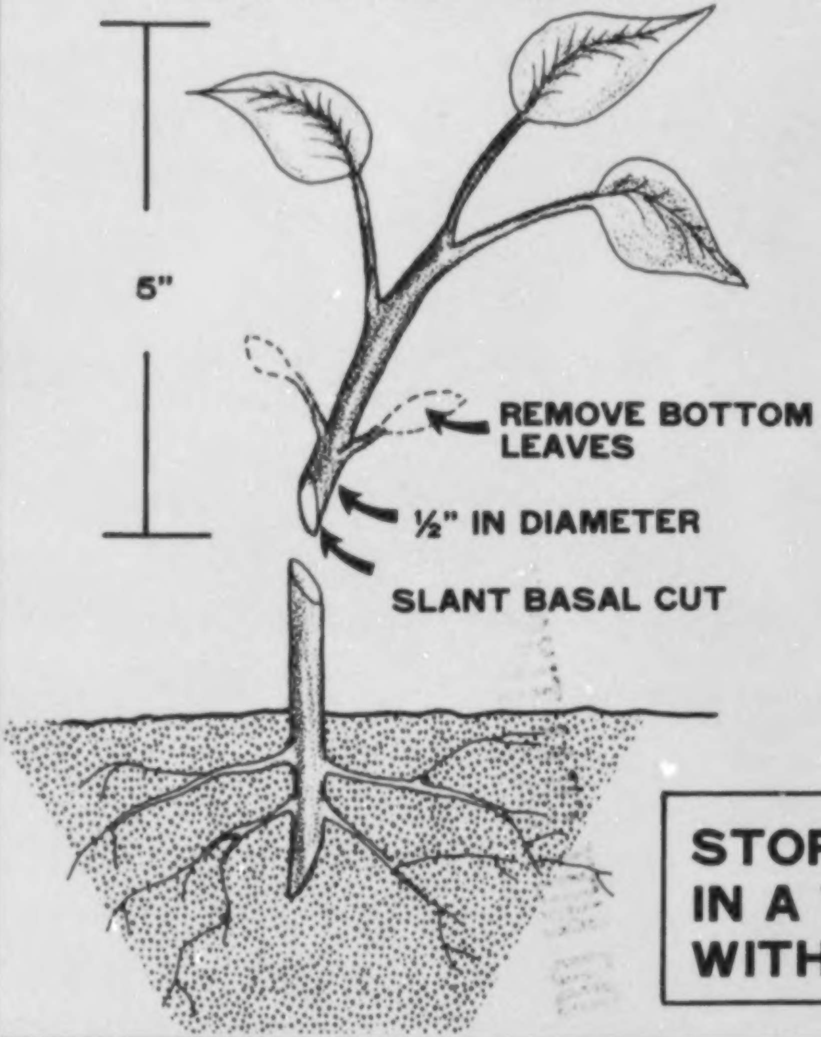
3. "Ornamental Horticulture for Pre-Employment Laboratory Training in Vocational Agriculture," Vocational Instructional Services, Texas A&M University, 1968.

4. "Ornamental Horticulture Plant Propagation: Asexual and Sexual Reproduction, " Virginia Polytechnic Institute, Blacksburg, Virginia, 1971.

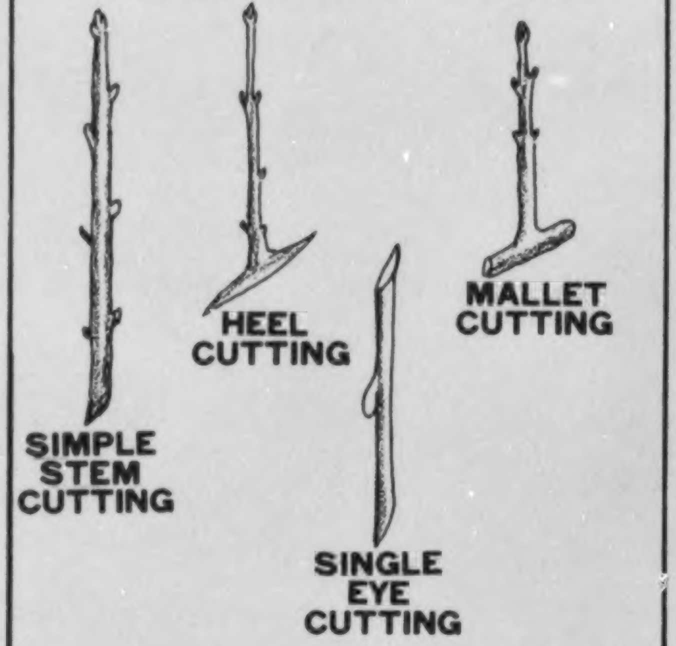
5. Bailey, Leo L., A Step-By-Step Guide To Landscaping and Gardening, Exposition Press, Hicksville, New York, 1974.

STEM CUTTINGS

SOFTWOOD CUTTING

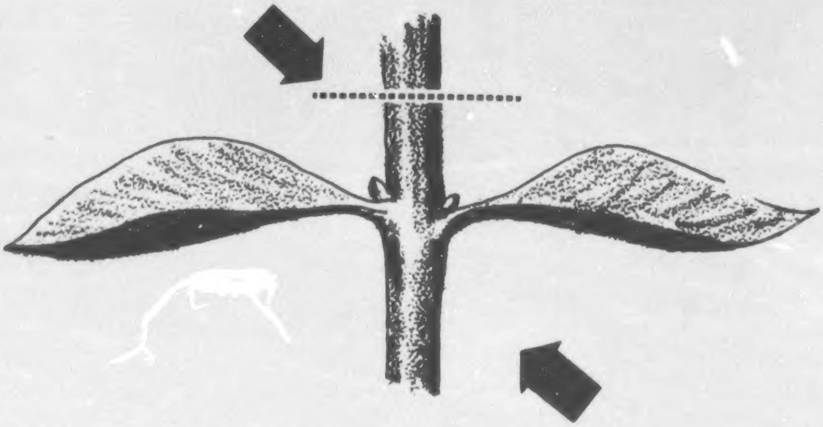

5"
REMOVE BOTTOM LEAVES
½" IN DIAMETER
SLANT BASAL CUT

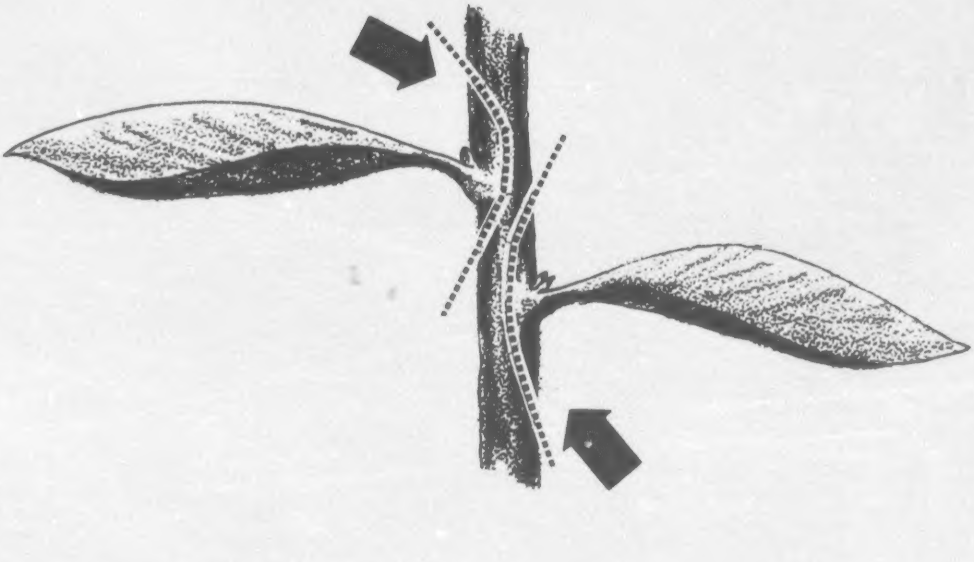
HARDWOOD CUTTINGS


SIMPLE STEM CUTTING
HEEL CUTTING
SINGLE EYE CUTTING
MALLET CUTTING

STORE HARDWOOD CUTTINGS IN A TRENCH OR BOX, COVER WITH 2" OF SOIL OR PEAT.

LEAF-BUD CUTTING

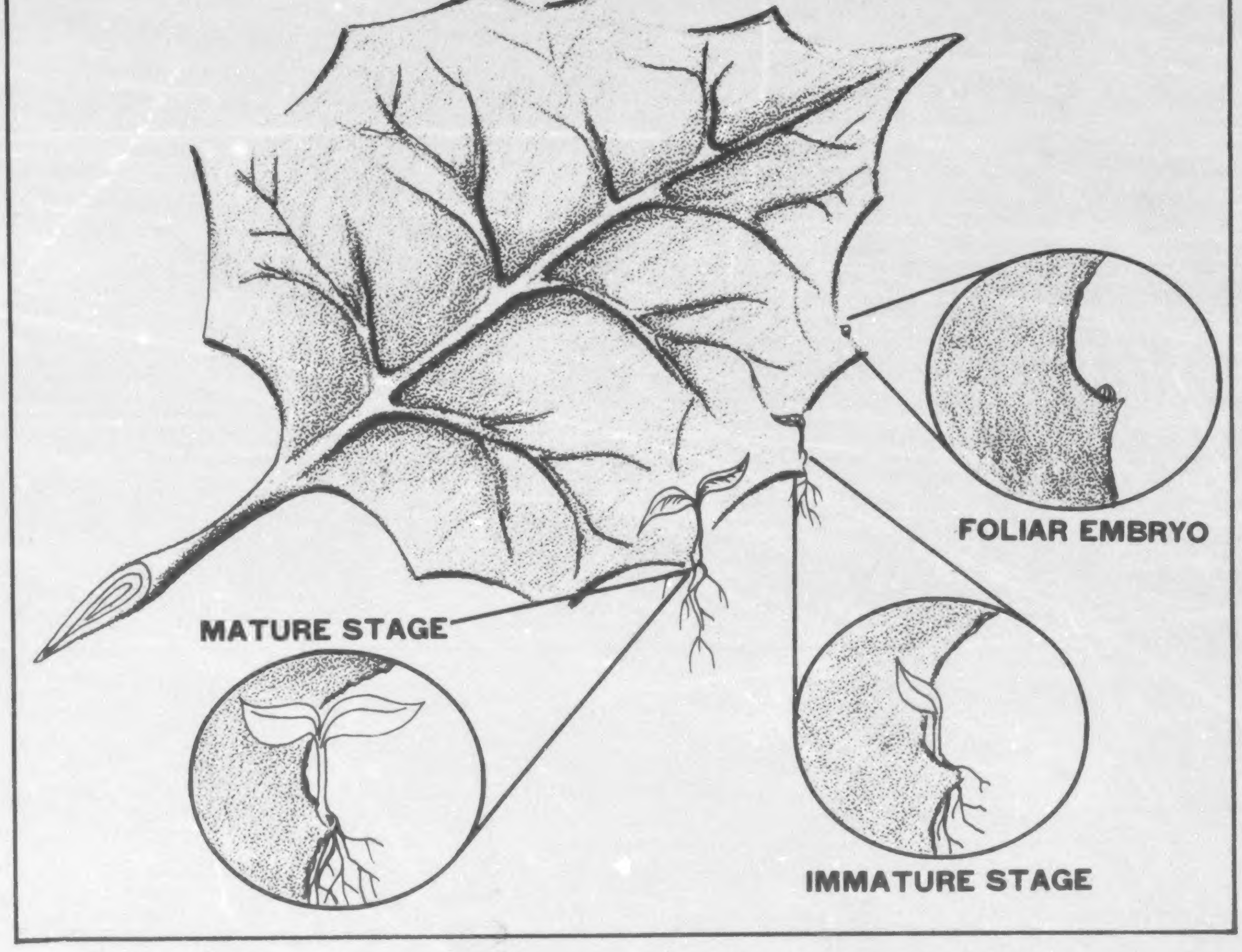




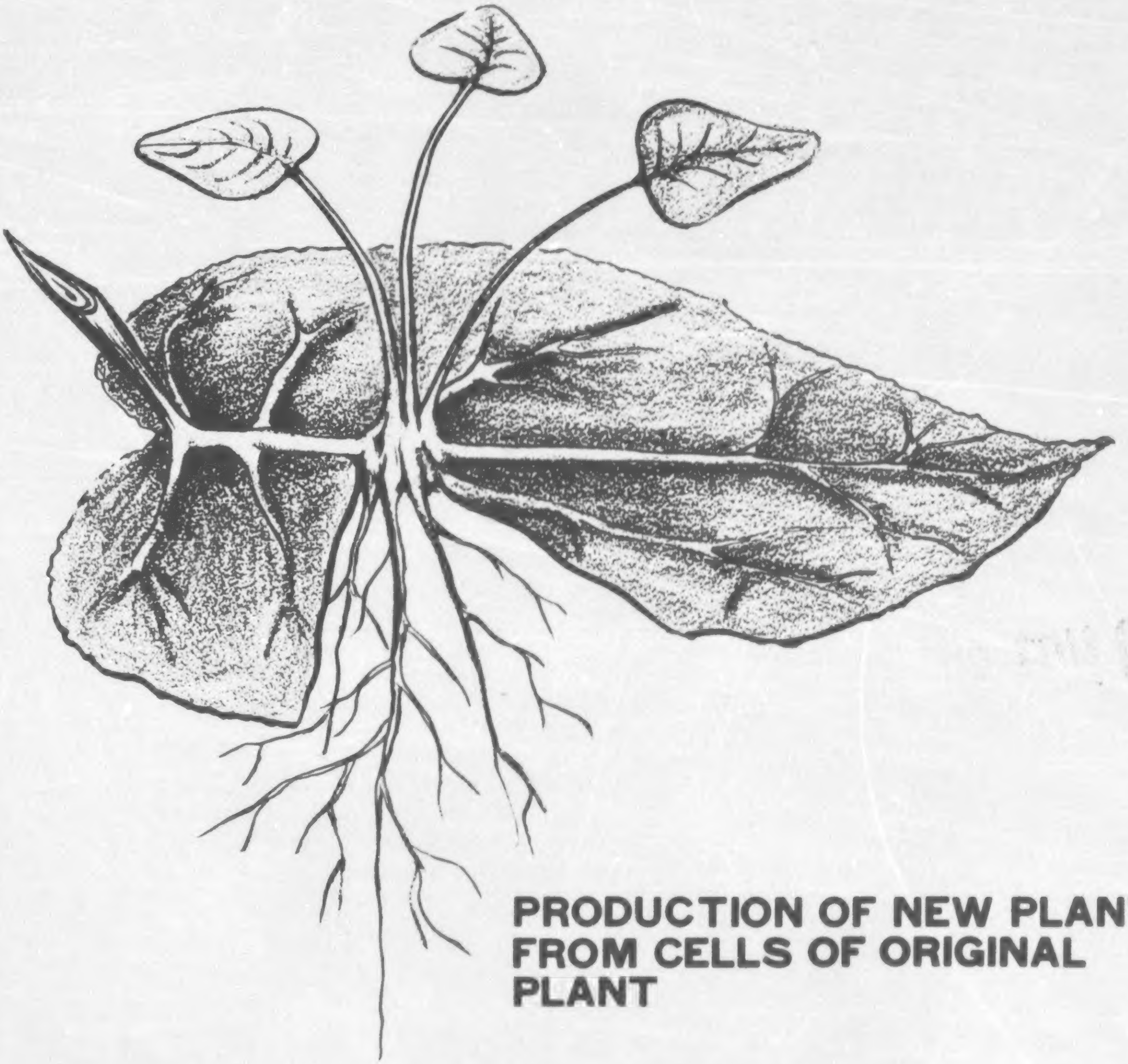
Pre-Lab, CVAE and VEH Horticulture

F-3
No. 2

PRIMARY MERISTEM


FOLIAR EMBRYO
MATURE STAGE
IMMATURE STAGE

SECONDARY MERISTEM

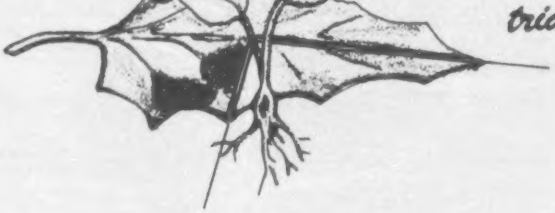


PRODUCTION OF NEW PLANT FROM CELLS OF ORIGINAL PLANT

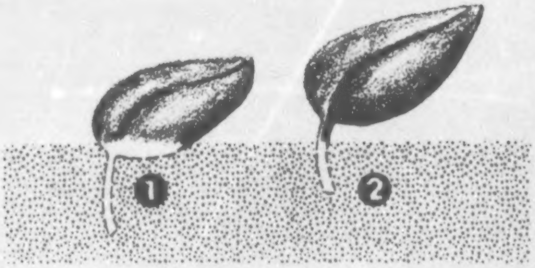
Pre-Lab, CVAE and VEH Horticulture

F-3
No. 4

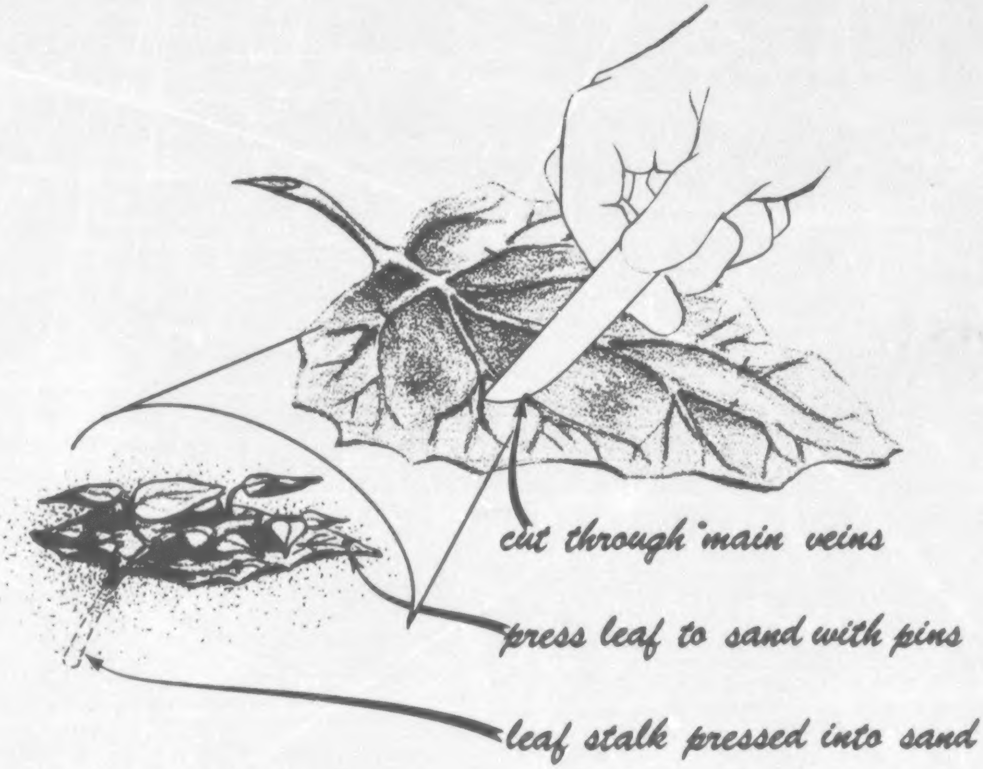
LEAF CUTTINGS



triangular cuttings



❶ *leaf blade &*
❷ *petiole cuttings*

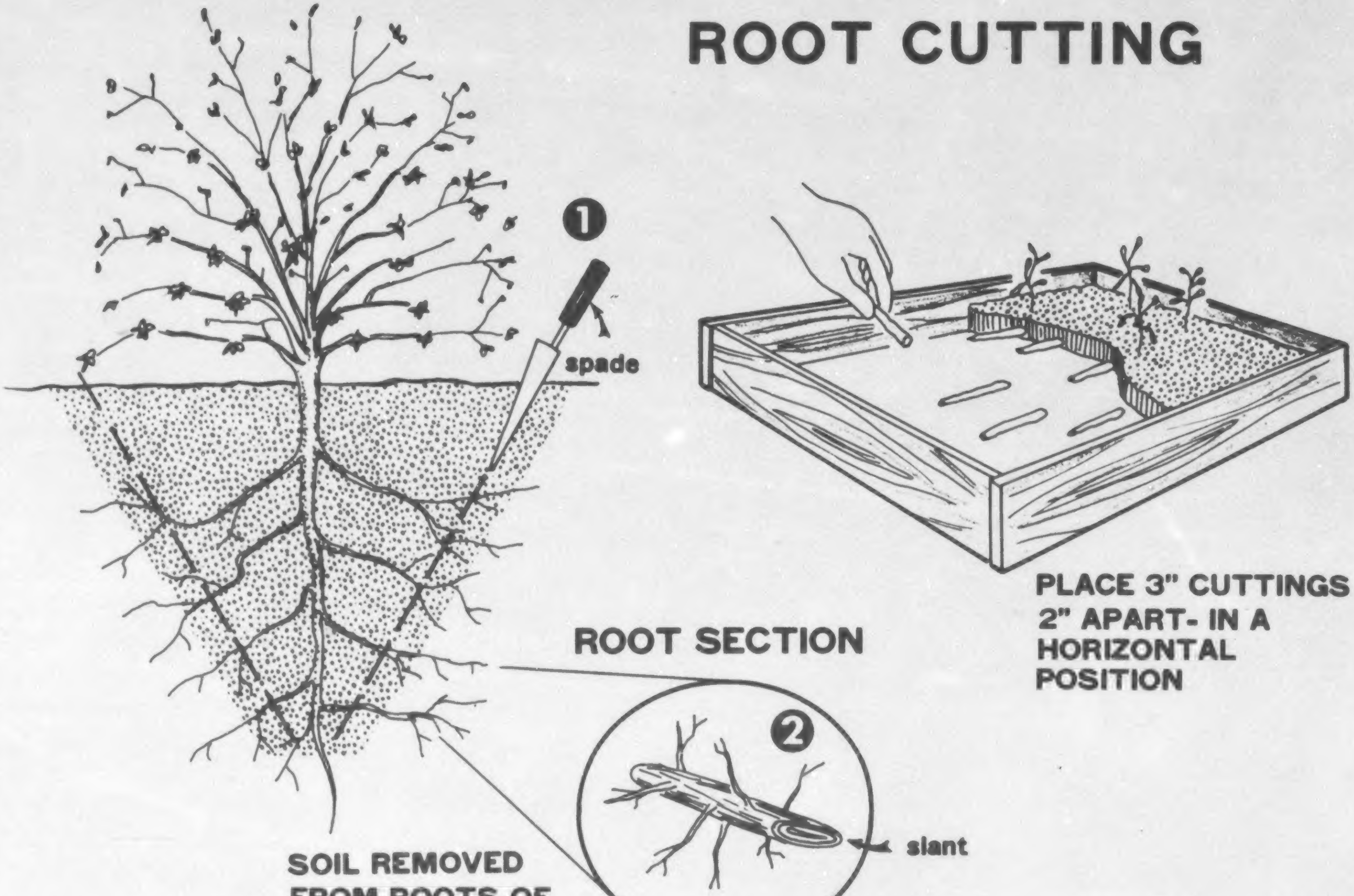


cut through main veins

press leaf to sand with pins

leaf stalk pressed into sand

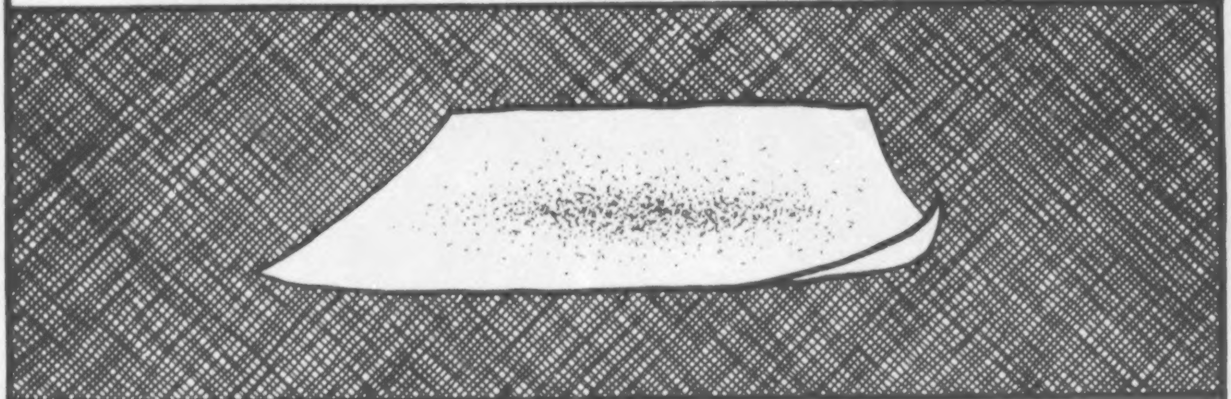
ROOT CUTTING


①
spade
ROOT SECTION
②
slant

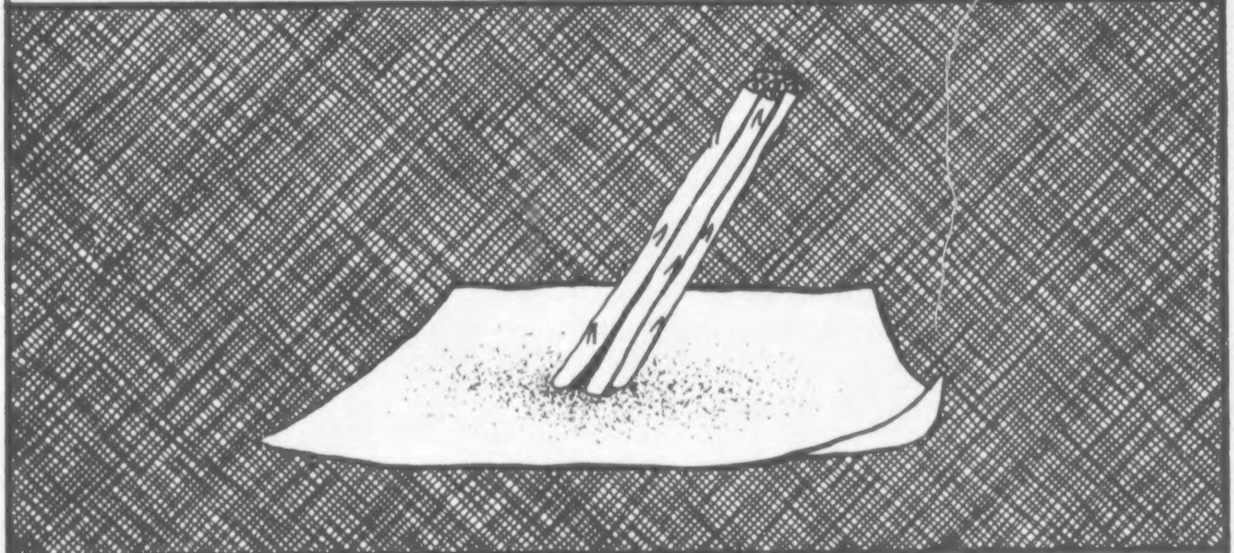
PLACE 3" CUTTINGS 2" APART- IN A HORIZONTAL POSITION

SOIL REMOVED FROM ROOTS OF PARENT PLANT - CUTTING THEN MADE

USING THE POWDERED FORM OF GROWTH REGULATOR



THIN FILM OF DUST ON PAPER



TAP BASE OF CUTTINGS ON DUST FILM (SLANTED CUT AT BASE FLAT ON PAPER)

Vocational Instructional Services
Agricultural Education

F-4
Agdex . 30/30 x 200

CVAE AND VEH HORTICULTURE

Unit F: Propagation of Plants

Topic 4: Propagating Plants by Layering, Separation, and Division

Note: All terms underlined are included in the "Glossary of Terms".

Suggested Procedures and Activities:

Although air layering is the only laboratory exercise listed at the end of the topic, it is suggested that the teacher demonstrate the other methods of layering.

1. Introduction

Layering may be described as a method of propagation in which stems or shoots are rooted while they are attached to the parent plant. Layering offers several advantages to the propagator: (1) it is economical, (2) large plants can be produced in a short period of time, (3) it is a simple method of propagation, and (4) plants that are difficult to propagate may be propagated by this method.

Several methods are used to produce plants by layering. An explanation is given for tip, simple, compound, air, mound, and trench layering.

2. Propagating Plants By Tip Layering

Transparency No. 1

Tip layering is taking the tip of a stem and placing it in the soil about 3 inches deep. The tip must be held in the soil. Tip layering occurs naturally in some plants when the tips touch the ground and develop roots. After roots have formed on the tip, the stem connecting the new plant to the parent plant is severed.

From three to five weeks are required for the tip to develop roots. After the roots develop, the new plant may be transplanted. The best time to transplant is in the spring. When transplanting, the tip should be pointed upward because the terminal bud develops from the tip.

3. Propagating Plants By Simple Layering

A branch of the parent plant is bent to the ground and covered with soil to propagate by simple layering. A cut or wound should be made in an area of the stem that is to be covered with soil. A pebble or tooth pick is placed in the cut, and the stem is covered with 3 to 6 inches of soil. The above ground portion of the stem is staked and exposed to form leaves and to perform normal plant processes.

The injury to the stem is made to encourage root development. Stem injury retards the downward movement of food and causes the plant to accumulate plant food in the injured area. This favors root development.

The length of time required for a layer to root and the time required before it may be severed from the parent plant varies with different species. Many species will make sufficient growth in one season to permit their being transplanted to a new location, while other species require two seasons of growth.

Many different types of plants may be propagated by simple layerage, but this method is generally restricted to plants that are difficult to propagate and home-grown plants.

4. Propagating Plants By Mound Layering

Mound layering, also called stool layering, can be used to successfully propagate most shrubs.

Transparency No. 2

Mound layering is performed by cutting the parent plant back to 2 to 4 inches above ground during the dormant season to encourage the production of vigorous shoots in the spring. After the rapid growth of the branches in the spring, the branches are again cut back to within 2 to 4 inches. In the middle of the summer, soil is mounded to cover about half of the new shoots. The temperature, weather conditions, and vigor of the plant will determine whether the new plants will have developed adequate roots by fall. If adequate roots have developed, the rooted shoots are severed from the parent plant and transplanted in nursery rows, where they are grown for one to two years. If the roots are poorly developed under the mound, the shoots are left attached to the parent plant for another year.

New plants also can be produced from overwintering crowns by lightly covering them with soil before growth starts in the spring. In most cases, the shoots may be separated from the parent plant in the spring and transplanted. These plants will bloom during the same season in which they are transplanted.

5. Propagating Plants by Trench Layerage

Trench layerages are made by digging a trench, placing a branch of the parent plant in the trench, and covering the branch with 2 to 5 inches of soil. Roots will develop at the nodes along the branch. After the roots are developed, the branch is severed from the parent plant. Each rooted node is planted, and hopefully a new plant develops and grows.

6. Propagating Plants by Compound Layerages

Transparency No. 3

This method of layering is similar to simple layering. The difference is that a branch is alternately covered and exposed. It is a common practice to injure the stem on the bottom of the covered portion of the stem. At least one bud should be present on each part of the exposed stem. The best time to make compound layerages is during late winter and early spring. It is a good method of propagating viny plants.

7. Propagating Plants by Air Layerages

Air layering is a successful means of propagating herbaceous plants, ornamental trees and shrubs, and fruit and nut trees; however, it is generally not used to propagate plants which root easily by other methods.

Air layering of plants grown indoors can be performed in any season, but it is more successful in warm weather. The best time for air layering of outdoor plants is during May and June. Generally outdoor plants require more time for rooting than indoor plants.

There are two methods of making air layerages. The one to use is determined by the plant being layered. The air layering of woody plants is discussed first.

Healthy, vigorously growing, one-year-old branches are selected for air layering. After selecting the branch, the propagator girdles the stem at a point 8 to 12 inches from the tip of the stem; however, if a longer stem is desired, it may be girdled below the last leaf on the steam. Moist sphagnum or peat moss is placed over the girdled area and around the stem on each side of the girdled area The moss-covered stem should be about the size of a baseball. The moss is tied in place with string, covered with a 10-inch square piece of plastic film, and tied or taped. The plastic should be tied to prevent the escape of moisture. Rubber bands or florist's ties may be used to tie the plastic.

Only one part of the stem is girdled when herbaceous plants are propagated. The stem is partially girdled by cutting an upward one-inch cut about one-third through the stem. A match stem or toothpick covered with a rooting hormone is placed in the cut to prevent it from growing back together and to promote root growth The same procedure is followed in applying the moss and plastic on all air layerages.

New roots should develop in 4 to 6 weeks and penetrate the moss. When the ball of moss is filled with roots, the new plant is ready to be severed from the parent plant and planted. The stem is cut below the moss ball, and the plastic and ties are removed. The moss should be left on the roots.

The new plant should be placed in a container filled with media composed of about one-third peat moss. The size of the container should be determined by the length of time the plant will remain in the container and the size that it will attain. The plant should be kept in a moist atmosphere until it becomes established in the container.

8. Propagating Plants By Specialized Buds, Stems, and Roots

Plants that are propagated by specialized buds, stems, and roots are usually herbaceous plants in which the shoots die back each year and the root system lives in a dormat state. The root system is a fleshy organ that produces new shoots the next growing season.

The two methods of propagating plants from specialized buds, stems, and roots are by separation and division. Plants that produce natural detachable structures (bulbs and corms) are propagated by separation, and plants that must be cut into sections are propagated by division.

A bulb is an underground bud that is enclosed by thick, fleshy scales and bears a growing point, known as a flower primordium. Most bulbs produce bulb scales. The outer scales contain stored food materials. The inner scales are leaf-like and enclose growing points which produce miniature bulbs, called bulblets. The bulblets are called offsets when they are grown. Aerial bulblets are called bulbils.

Transparency No. 4

The two types of bulbs are tunicate and non-tunicate (scaly type). The tunicate has a covering of dry membranous outer scales which prevent dehydration of the bulb and injury to the inner scales. The inner scales are concentric layers of fleshy scales. The tulip is an example of this type.

Adventitious roots develop around the outside edge of the basal plate when the bulb begins to grow. The scaly type bulb does not have the tunic (covering) found on the tunicate and must be handled with care to avoid injury. Lilies are examples of this type. They must be kept moist, as drying injures the bulb. Both basal and stem roots are produced in the summer or later in the year.

Various species of bulbs have different environmental requirements which are important in their propagation. There are both spring and fall bulbs. Spring bulbs should be planted in September, and summer and fall bulbs are planted in March.

Bulbs can be propagated in two principal ways. The tunicate bulb can be left in the ground for several years and will produce a bloom each year. When the flowers become small and few in number, the bulb should be dug. This should be done after they have bloomed. Surrounding the parent bulb will be several bulblets. These are removed and planted in the fall to propagate new plants.

The scales from the scaly type bulb can be removed and planted to produce new plants. This type can also be propagated by digging in the fall, cutting the old bulb away at the bottom, and planting the bulblets attached to the stem above it.

Transparency No. 5

The types of specialized stems are runners, stolons, rhizomes, corms, tubers, and pseudobulbs. An explanation of each is given.

A runner is a horizontal growing stem that arises from a leaf axis at the crown of a plant. It forms a new plant only after rooting at the terminal node.

Stolons are similar to runners but different in that they produce adventitious roots when the runner comes in contact with the ground.

A rhizome is a stem in which the main axis grows horizontally at or just below ground level. The vertical growth consists of shoots arising from various nodes.

Corms can be identified by the swollen base at a stem axis. They are enclosed by dry, scale-like leaves. Corms are distinguished from bulbs by their solid structure, distinct nodes, and internodes. A corm is composed mostly of parencyhma cells, which serve as storage for food. It contains either fibrous roots or fleshy contractile roots. Miniature corms are called cormels; they develop on the parent corm.

Tubers have all the parts of a typical stem. A tuber may be referred to as a modified stem which develops below the ground, as a result of swollen subopical portion of a stolon. For example, the "eyes" of an Irish potato are nodes; they have small buds and leaf scales.

A pseudobulb is an enlarged fleshy structure composed of one or several nodes. They arise either laterally or terminally from rhizomes. The orchid is an example.

There are several kinds of specialized roots, but shoots and tuberous roots are the kinds discussed in this topic.

Transparency No. 6

Tuberous roots are different from true tubers in that they lack nodes. On the distal end of tuberous roots, fibrous roots are formed and buds are present in the crown or stem only. Tuberous roots are formed by sweet potatoes, dahlias, and tuberous rooted begonias.

Bulbs (using the word in a broad sense to include all bulb-like organs) grown in a greenhouse are of two distinct types. The first type includes such bulbs as amaryllis, gloriosas, and haemanthus. They may be grown in the greenhouse for several years. They normally bloom annually. The second type includes such plants as hyacinths, lilies, narcissi, and tulip. They may be forced to bloom indoors but must be planted outdoors after they bloom, because they will not produce satisfactory flowers indoors the second season.

The separating and dividing of bulbs is not complicated, and a person will not experience any difficulty after he has propagated a few plants. Illustrations showing the methods of separating and dividing bulbs are given.

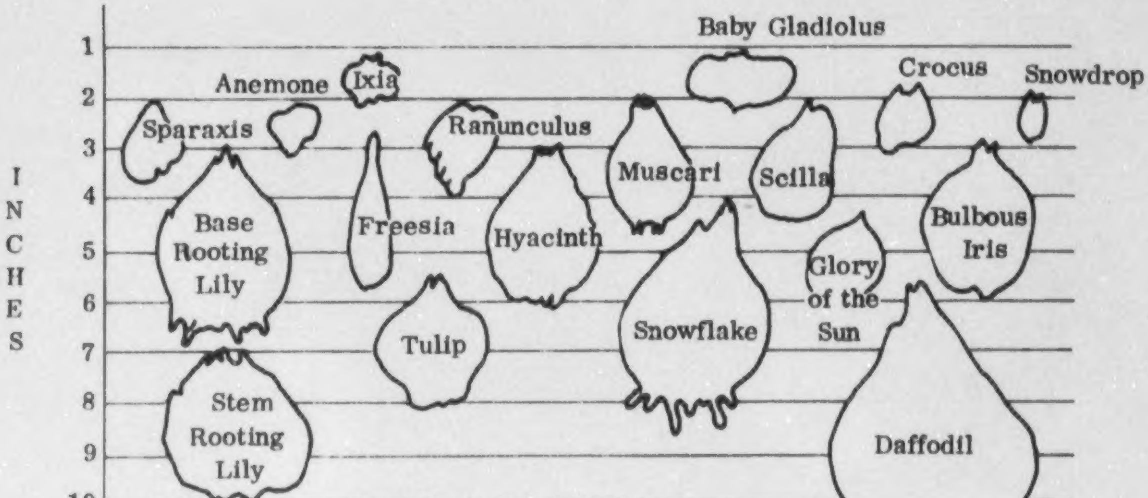
Transparency No. 7

Planting Bulbs

To insure that bulbs will continue to produce beautiful blooms for several years, the grower must give them a good start. If they are to be planted outdoors, the soil should be dug to a depth of 12 to 18 inches. It is not necessary to add anything to fertile soils that are in good condition. A mixture of peat moss, horticultural perlite, and fertilizer should be mixed with infertile soils.

The depth to plant bulbs is determined by the species being planted. The rule of thumb that may be applied in determining depth to plant is two and one-half to three times the greatest diameter of the bulb. This is particularly true of bulbs planted in the early fall. Since bulbs planted later in the fall will not have as much growing time, they should be planted at a shallower depth. The following chart shows the proper planting depth of some bulbs.

Planting Depth of Bulbs



Some of the most decorative bulbs that may be grown in the greenhouse are included on the following list.

Achimenes
Amaryllis
Brodiaea
Calla Lilies
Caladium
Crinodonnas

Gloriosas
Gloxinias
Habranthus
Haemanthus
Hippeastruisus (Amaryllis)
Hyacinths

Oxalis
Schizabasopsis
Smitheanthas
Sparaxis
Tritones
Tuberous Begonia

Crinums
Cyrotonthus
Daffodils
Euchias
Eucomis
Freezia
Gladiolus
Hydrosome
Humenocullis
Hahlerius
Lachenalias
Narcissus
Nerines
Ornithogalum
Tulips
Urginea
Veltheimias
Watsonias
Zantedesalius

LABORATORY EXERCISE NO. 1

Activity:
Air layering of woody and herbaceous plants

Materials:
Plants that can be air layered
Rooting hormone
Sphagnum moss
Plastic, 10 inches square
Ties (tape or florist's ties)

Procedure

Woody Plants

1. A one-year-old healthy branch is selected.
2. Stem is girdled 8 to 12 inches from the tip.
3. The girdled area is covered with moss.
4. The plastic square is placed over and around moss and is tied.

Herbaceous Plants

1. A one-year-old healthy branch is selected.
2. The stem is girdled by cutting an upward one-inch cut about one-third through the stem.
3. A match stem or toothpick that has been covered with a rooting hormone is placed in girdled cut.
4. Moss is placed around the girdled cut.
5. The plastic square is placed around the moss and tied.

LABORATORY EXERCISE NO. 2

Activity:
Planting and growing bulbs in pots

Materials:
Bulbs
Pots
Fungicide and insecticide dusts
Media

Procedure:

1. The bulbs to be planted are selected.
2. The bulbs are treated with a fungicide and an insecticide to prevent their rotting and to protect them from insects.
3. The bulbs are placed in a pot. About six bulbs, depending on their size, can be placed in a nine-inch pot. This will provide several blooms. Bulbs are placed in the pot and separated with media. The bulbs are placed even with the top of the media.
4. Pots should be placed in a trench and covered with six inches of peat moss.
5. Pots and covering should be kept moist.
6. When the leaves appear, the pots should be placed in a warm place and given adequate sunlight.
7. The bulbs should be fertilized when the leaves are about three inches high.
8. If the bulbs are going to be grown in the pots the second year, they should be repotted in the fall.

REFERENCES:

1. "The Propagation of Ornamental Plants," Texas Agricultural Experiment Station, B-1093.

2. "Ornamental Horticulture Plant Propagation: Asexual and Sexual Reproduction," Virginia Polytechnic Institute, Blacksburg, Virginia, 1971.

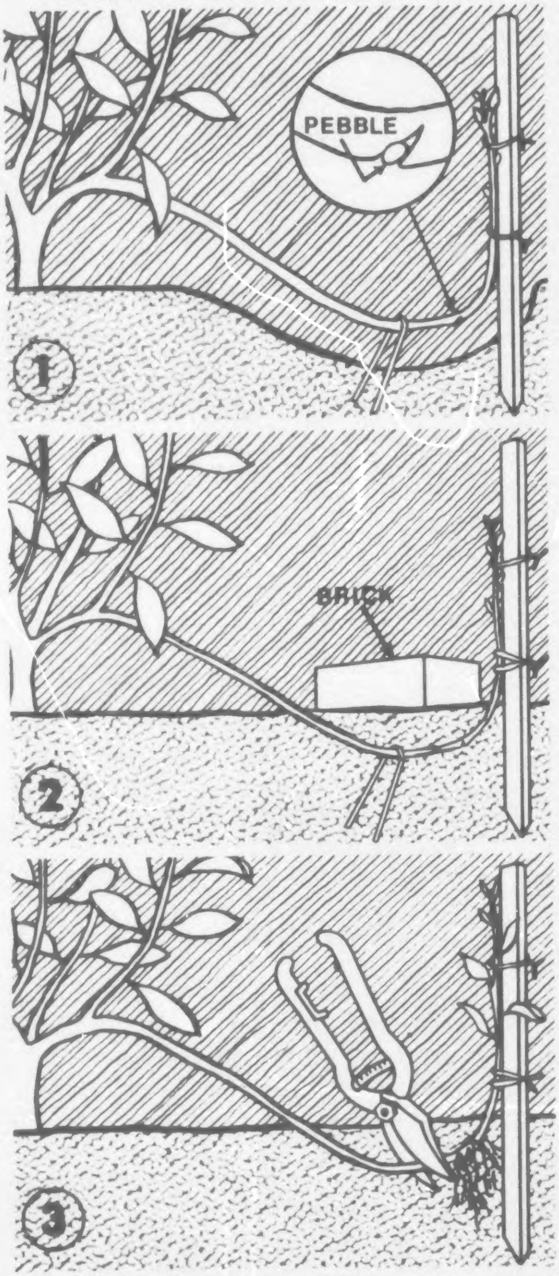
3. "Propagating Horticultural Plants," Vocational Instructional Services, Texas A&M University, 1969.

4. "Basic Gardening Illustrated," Lane Books, Menlo Park, California, 1970.

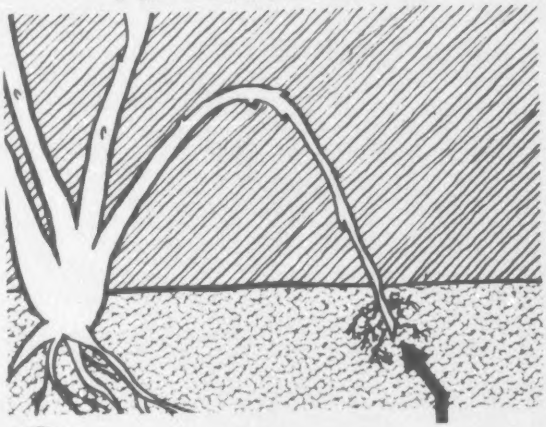
5. Hartmann, Hudson T. and Dale E. Kester, Plant Propagation, Prentice-Hall, Inc., Englewood Cliffs, New Jersey.

TIP AND SIMPLE LAYERAGES

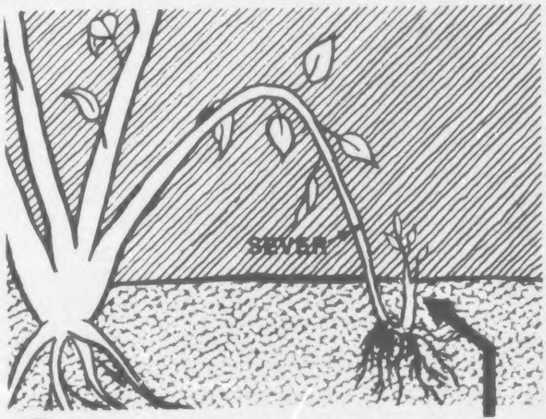
SIMPLE LAYERING


PEBBLE
1
BRICK
2
3

TIP LAYERING

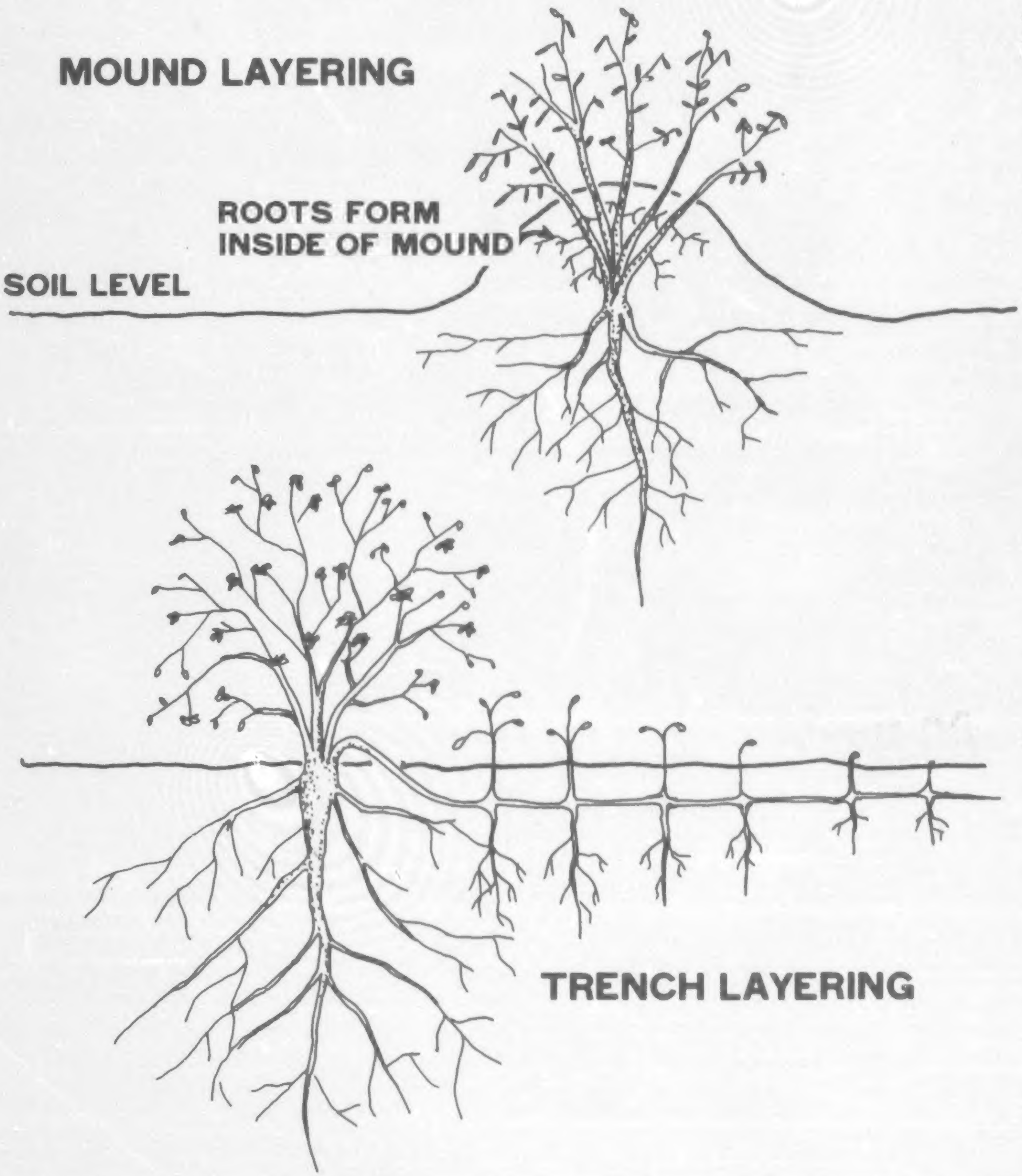


① Terminal bud 3"– 4" deep

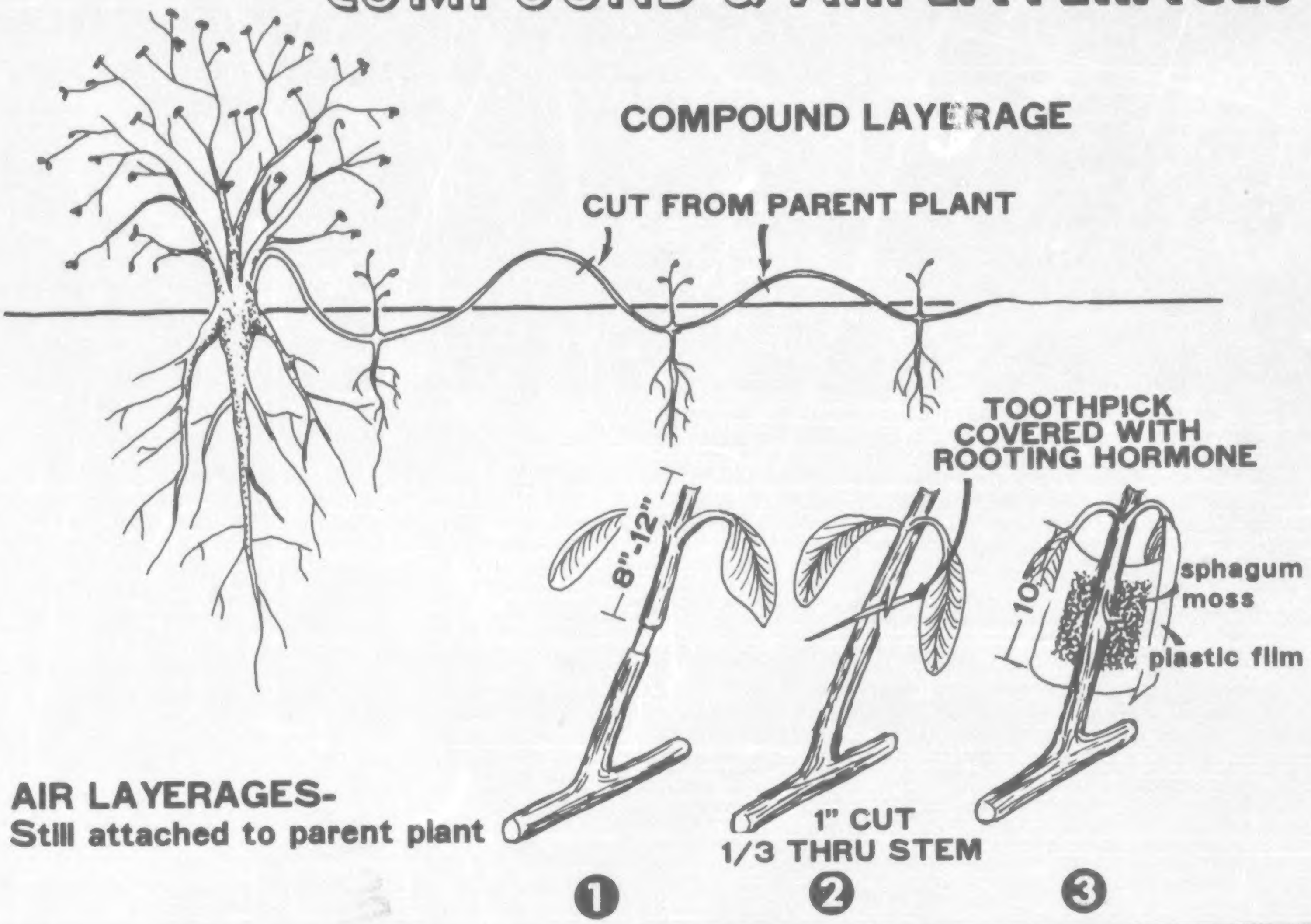


② New growth from terminal bud

MOUND & TRENCH LAYERAGES

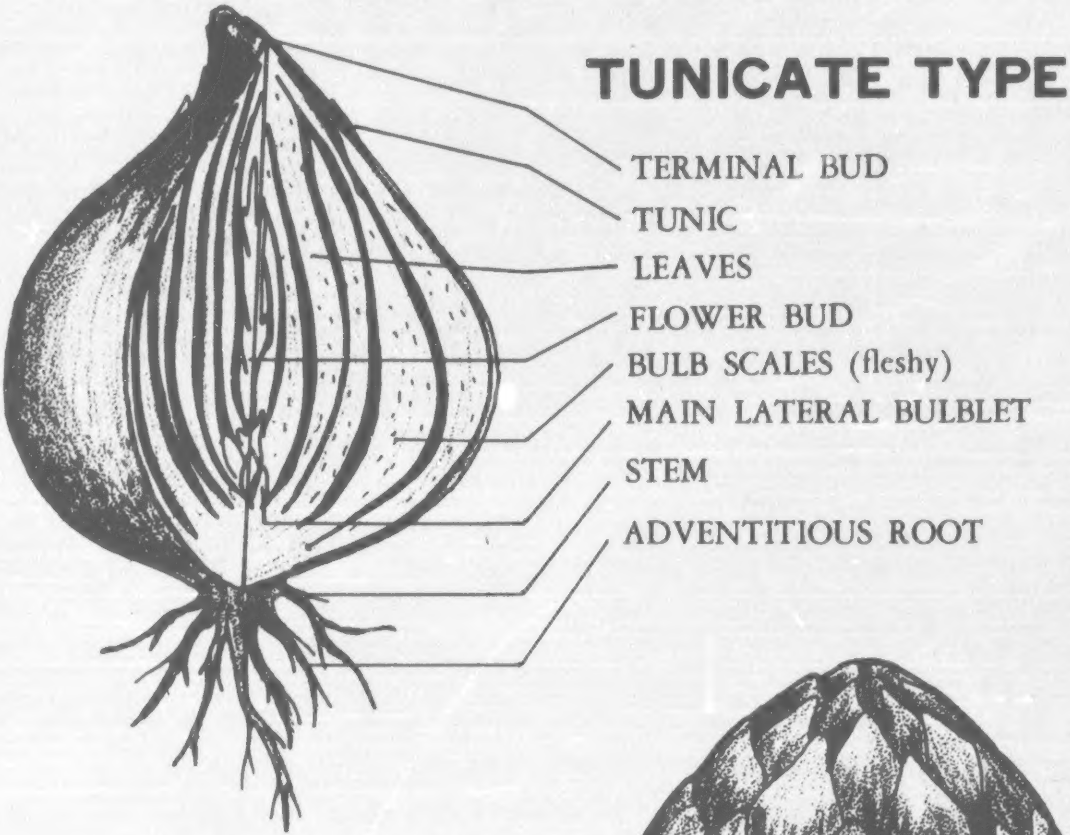

MOUND LAYERING
ROOTS FORM INSIDE OF MOUND
SOIL LEVEL
TRENCH LAYERING

COMPOUND & AIR LAYERAGES

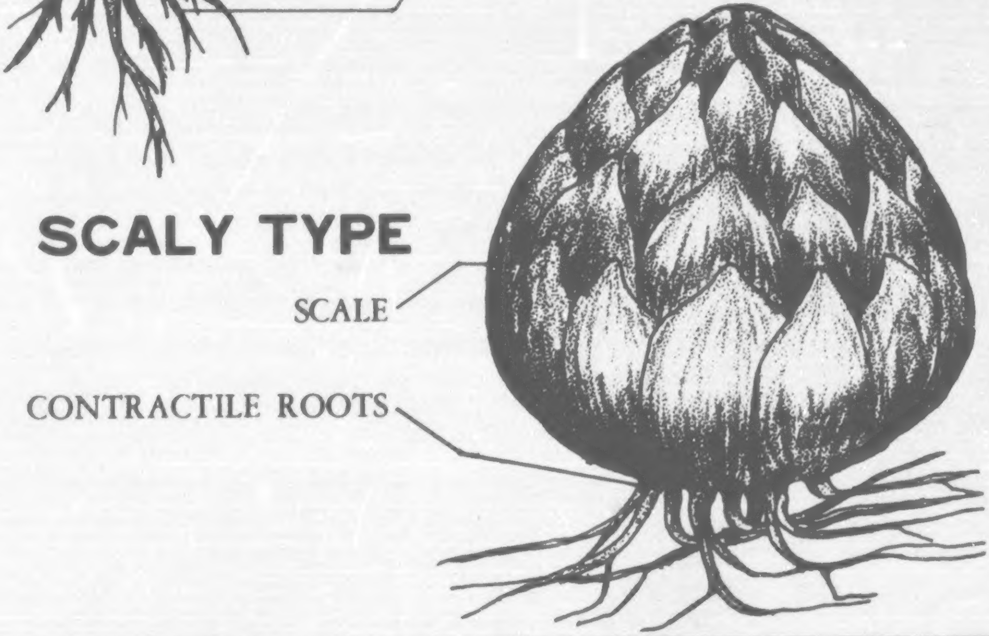

COMPOUND LAYERAGE
CUT FROM PARENT PLANT
TOOTHPICK COVERED WITH ROOTING HORMONE
8"-12"
10"
sphagum moss
plastic film
AIR LAYERAGES-
Still attached to parent plant
1" CUT
1/3 THRU STEM
❶
❷
❸

TYPES OF BULBS

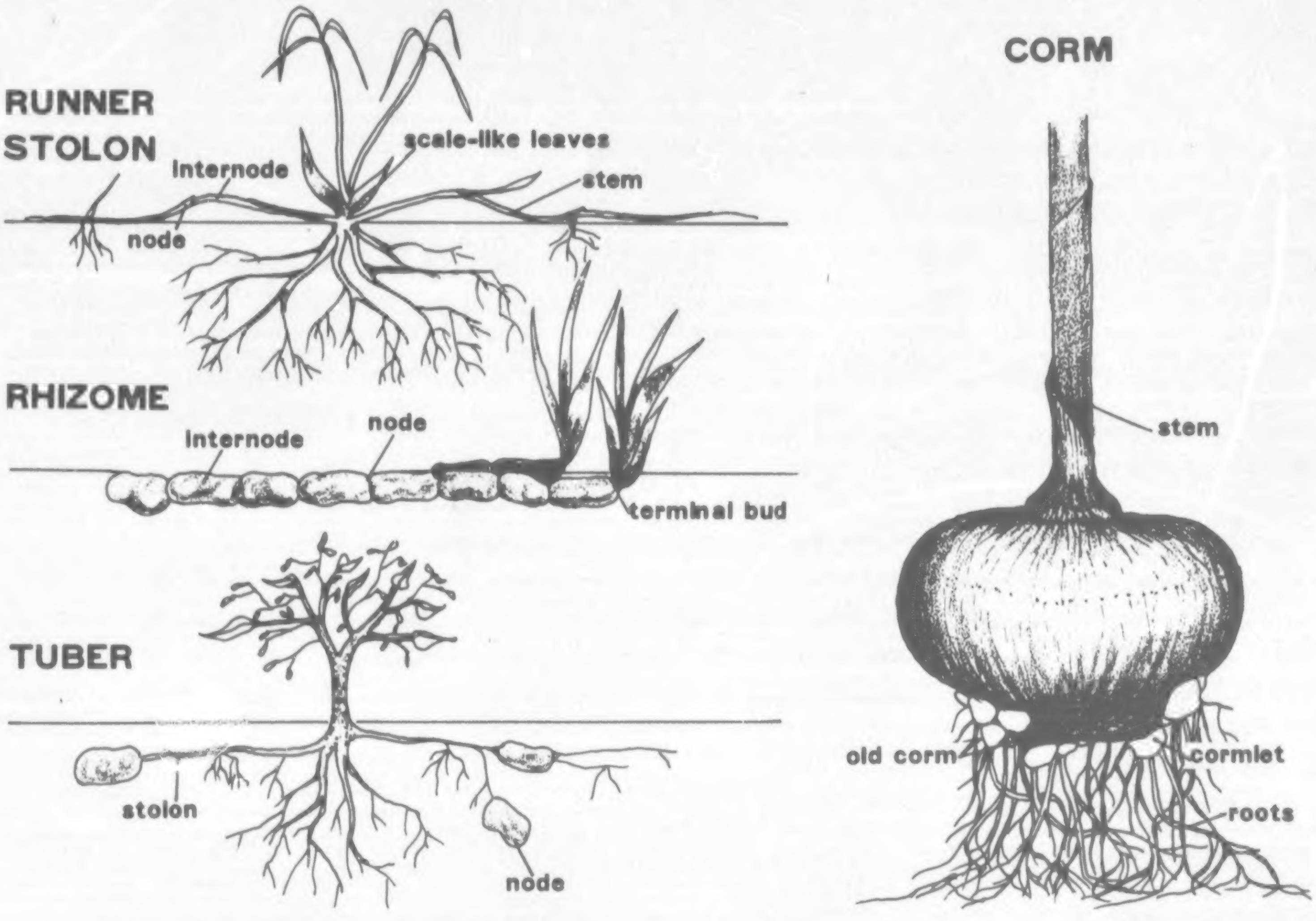
TUNICATE TYPE


TERMINAL BUD
TUNIC
LEAVES
FLOWER BUD
BULB SCALES (fleshy)
MAIN LATERAL BULBLET
STEM
ADVENTITIOUS ROOT

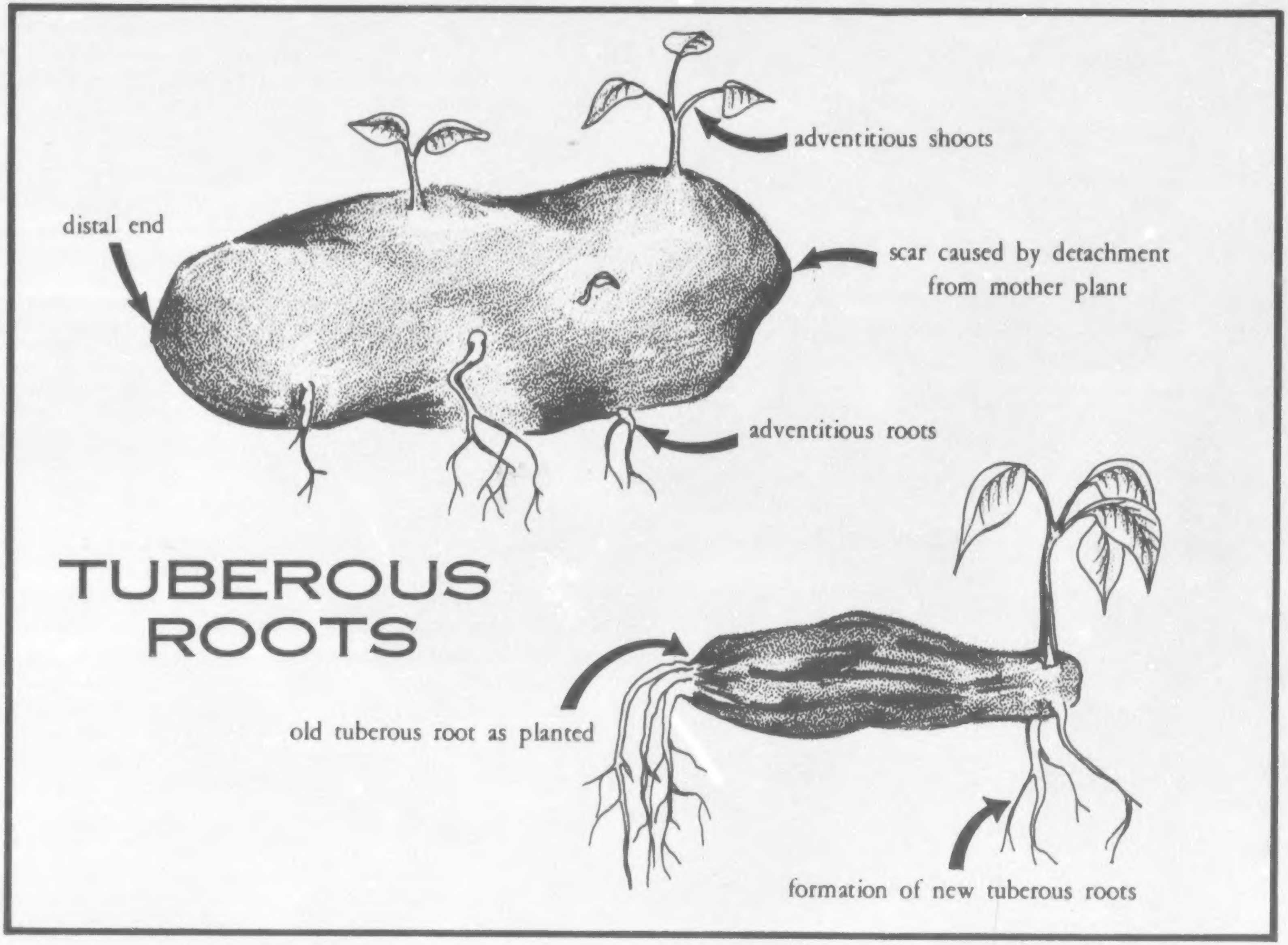
SCALY TYPE


SCALE
CONTRACTILE ROOTS

SPECIALIZED STEMS

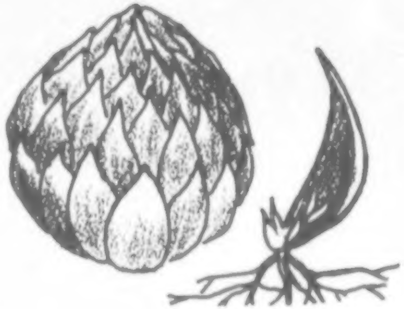

RUNNER
STOLON
internode
scale-like leaves
stem
node
RHIZOME
internode
node
terminal bud
TUBER
stolon
node
CORM
stem
old corm
cormlet
roots

TUBEROUS ROOTS

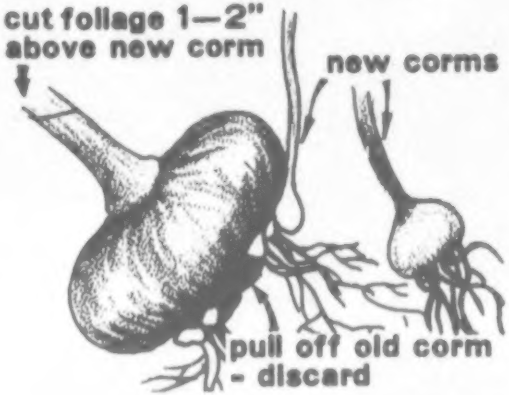

adventitious shoots
distal end
scar caused by detachment from mother plant
adventitious roots
old tuberous root as planted
formation of new tuberous roots

SEPARATING AND DIVIDING BULBS

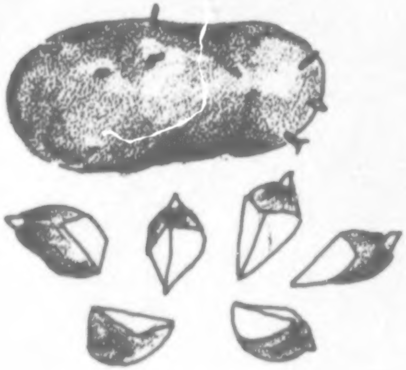
SCALE PROPAGATION



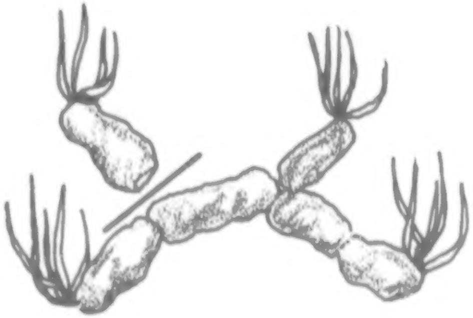
CORM SEPARATION


cut foliage 1—2" above new corm
new corms
pull off old corm - discard

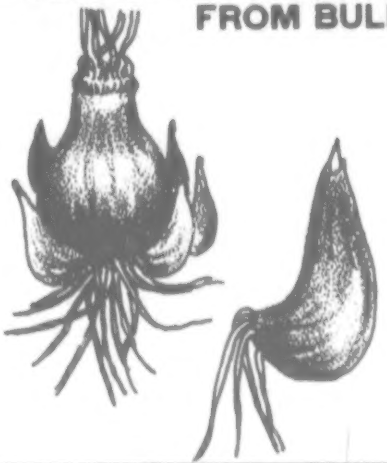
TUBER DIVISION



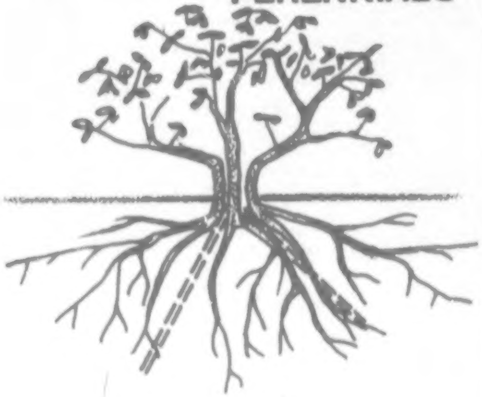
RHIZOME DIVISION



SEPARATION OF BULBLETS FROM BULB



DIVISION of HERBACEOUS PERENNIALS



Vocational Instructional Services
Agricultural Education

F-5
Agdex .30/30 x200

CVAE AND VEH HORTICULTURE

Unit F: Propagation of Plants

Topic 5: Propagating Plants By Grafting

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedure and Activities:

The procedure for making each of the grafts discussed in the topic is given under the heading designating the type of graft. The materials in the topic may be presented while demonstrating each graft.

1. Introduction

Grafting is the uniting of one part of a plant with another plant. The growth produced by the stem of a successful graft produces wood and fruit like that of the parent plant. The plant on which the graft was placed produces the same wood and fruit as it did before it was grafted.

It is much easier to produce new plants from seeds, but some plants cannot be reproduced in this manner. There are three principal reasons for grafting: (1) Some plants cannot be reproduced from seeds, (2) Plants produced from some seeds do not breed true, and (3) Grafts are made to produce plants of the opposite sex.

In order to produce plants by grafting, the propagator must understand the basic fundamentals. Terms used to explain the grafting process are stock, scion, and cambium. The stock is the plant that receives the graft. The scion is the stem or graft wood which contains one or more buds and is inserted into the stock. The soft layer of tissue located between the bark and the wood is the cambium. Through cell division, the cambium has the ability to produce new bark and wood. When bark is removed from the stem, it is slipped off at the cambium.

The best time to graft deciduous trees and shrubs is just before the buds begin to swell in late winter or early spring. Only healthy plants should be grafted.

Plants must be related botanically for plants to be grafted successfully. However, some related plants cannot be grafted. For example, an apple and pear are related, but they cannot be grafted successfully.

Probably the best time to collect graft wood is before the first freeze in the fall. Wood from healthy one-year-old wood (last season's growth) with well-developed buds should be selected. Also, it is desirable to select wood with short internodes.

The wood should be placed in moist sphagnum moss, wrapped in plastic, sealed air-tight, and stored in refrigeration at about 40° F. The graft wood is taken directly from cold storage and used immediately.

After the graft has been completed, grafting wax or some other air-tight covering should be used to prevent the graft from drying out and the entrance of decay-producing organisms.

There are several different types of grafts, and the type to use will depend upon the species of plant and its size.

2. Propagating Plants by Cleft and Bark Grafting

The cleft graft is used to introduce a new or improved variety on large shrubs and trees that have to be top-worked. The best time to cleft graft is just before the buds begin to swell in the spring.

Transparency No. 1

The ideal size branch on which to apply a cleft graft is one that is 2 inches or less in diameter. Cleft grafts on trees should be applied close to the trunk and not more than 5 feet from the ground After the branch is cut, the stub is split 2 or 3 inches with a heavy knife or grafting tool The lower end of the scion is cut into a 1-1/2 to 2-inch wedge. The cut is started at one side of the lowest bud and the inside cut of the wedge is made slightly thinner than the outside. The two bevels of the wedge should be cut continuously and uniformly to insure cambial contact of the stock and scion along the entire length of the beveled cut. The top of the scion should be cut with a sloping cut about 1/4 inch above the upper bud. The scion is then inserted into the edge of the cleft so that the cambiums coincide. Since the bark of the stock is usually thicker than that of the scion it is not necessary to set the scion so that the outer edge of the woody portion (xylem) of the scion is even with the outer edge of the woody portion of the stock. About 1/2 inch of the cut surface of the scion should be exposed. This makes for a stronger union. Only one scion should be used on stocks of one inch or less in diameter. On larger stocks two scions may be used.

Two different methods of sealing the graft from air, moisture, and decay-causing organisms are used. One method is to cover the stock with aluminum foil. The foil is lapped down the sides of the stock for 2 or 3 inches. Then holes are cut in the corners of the plastic bag to allow the bag to be slipped over the scions. The bag is tied securely around the scions and the stock. The exposed end of the scion is painted with shellac or covered with wax.

Another method of sealing the graft is to cover the stock with grafting wax. If wax is used, it should be checked in a week to determine if it has cracked and is admitting air. Another coat of wax should be applied if the first coat has cracked.

Transparency No. 2

The bark graft is a substitute for the cleft graft. The stock is sawed off as described for the cleft graft. The bark graft is applied after the bark begins to slip. A slit is made through the bark of the stock for each scion that is going to be placed on the stock. Then the scion is prepared by making a wedge-shaped cut for 1 to 1-1/2 inches on one side of the scion. The wedge-shaped scion is inserted between the bark and the wood. A small brad is nailed through bark and scion and into the stock. The grafts are covered with foil and plastic or grafting wax.

3. Propagating Plants by Inlay Grafting

Inlay grafting is another method used to introduce new or improved varieties on large shrubs or trees. Plants to be inlay grafted should be topworked while they are dormant (January through the middle of March). The scion is placed on the dehorned limb after the plant starts to grow and the bark begins to slip. This is usually about ten days after the plants starts to leaf out.

Transparency No. 3

The inlay graft is made by sloping the scion 2 to 2-1/2 inches Approximately one-third of the scion is included in the sloping cut. Another sloping cut about 3/4 to 1 inch in length is made on the opposite side of the first sloping cut.

A smooth area is selected on the stock to prepare for making the graft. Since the bark of the stock is usually very thick, the propagator may wish to remove a thin layer of the rough outer bark. The long sloping cut on the scion is placed against the stock and about 1/4 inch above it, and cuts are made on each side of the scion through the bark of the stock and to the bottom of the scion. The knife should be held so that the blade will cut slightly under the edge of the scion.

A small portion of the rectangle-shaped bark is pulled from the top of the limb with the top of the knife blade, and the graftwood is inserted behind the flap and pushed down until 1/4 inch of the longer sloping cut is above the stock. If the cuts were made correctly, the graftwood should fit snugly behind the flap.

The bark flap covering the graftwood should be cut about 1/2 inch above the shorter sloping cut and a nail driven through the flap and graftwood and into the stock. The nail should be driven through the graftwood just above the top of the short slanting cut. Another nail should be driven through the graftwood and into the stock just below the crown of the limb.

The graft should be covered with one of the sealers mentioned above. The tip of the scion also should be covered.

4. Propagating by Side Grafting

This method of grafting is used on stock too small for cleft or inlay grafting and to add branches where none are growing. Best results are obtained with stocks that are 1/4 to 3/8 inch in diameter and scions of the same size. The scion should not be larger than the stock.

Transparency No. 4

An oblinque-angled cut is made on the stock, and sloping cuts are made on the scion similar to those made on a cleft graft. The stock is bent, and the scion is inserted into the stock so that cambium layers meet on one side The springback of the stock should hold the graft, but it also should be tied Grafting wax is then applied to the graft and the tip of the scion.

5. Propagating by Tongue or Whip and Wedge Grafting

This graft is used on young plants that have small branches (about the same size as the scion).

In making a whip graft, a long sloping cut about 1-1/2 inches long is made on the scion. A second cut is made on the surface of the first cut. A slit or tongue is made about 1/2 inch long about one-third the distance from the toe to the heel on the scion. This is done by making a downward cut partially across the grain and in the direction of the heel. The stock is prepared in the same manner.

The stock and scion are joined by placing the two cut surfaces together and slipping the tongue of the scion inside the tongue of the stock. If the scion is smaller than the stock, it is set on one side so that the cambium areas of both stock and scion are in direct contact. If the toe of either the stock or scion extends beyond the heel of the other, it should be cut off. The stock should be wrapped with rubber bands or string and covered with grafting wax. The wrapping should be removed as soon as the scion has started to grow or calluses to prevent girdling of the stem.

Another method sometimes used to graft small stocks is the wedge graft. Slanting cuts similar to cuts made on a cleft graft are made on the scion. The stock is split, and the propagator places the scion in the stock. The graft is tied and covered with grafting wax.

6. Caring for Grafts

Transparency No. 5

After the grafts have been applied, they should be inspected periodically for cracks in the grafting wax or damage to the plastic covering After the grafts begin to grow, lath strips should be tacked to the stock to furnish support for the new branches String is used to anchor the grafts to the lath strip.

If several grafts have been applied to one limb one of the grafts should be selected as the dominant graft, and the growth of others should be discouraged. The unwanted grafts are pruned back to 3 to 4 inches at the end of the first year's growth, and the dominant graft is allowed to grow to maturity. If only one graft grows, the dead shoulder opposite the growing graft should be cut off and a wound dressing applied.

The process that takes place in a growing graft is that the layer cells in the cambial region of the scion and stock produce parenchyma cells which intermingle and form callus tissue. Certain cells in the callus tissue form new cambium cells, and these cells produce new vascular tissue (xylem on the inside, phloem on the outside). This establishes a vascular connection. A grafted union in reality is a healed wound with a foreign piece of tissue incorporated into the healed wound.

LABORATORY EXERCISE

Activity:

Demonstrate the procedure to follow in propagating plants by cleft, bark, inlay, side, tongue or whip, and wedge grafts

Materials:

Grafting tools (saw, pruning shears, grafting knife, whetstone, mallet, grafting tool for making cleft grafts)
Grafting wood
Grafting wax
Aluminum foil
Plastic sacks
Ties
Brads or nails

Procedure:

The procedure for making each graft is explained in the topic.

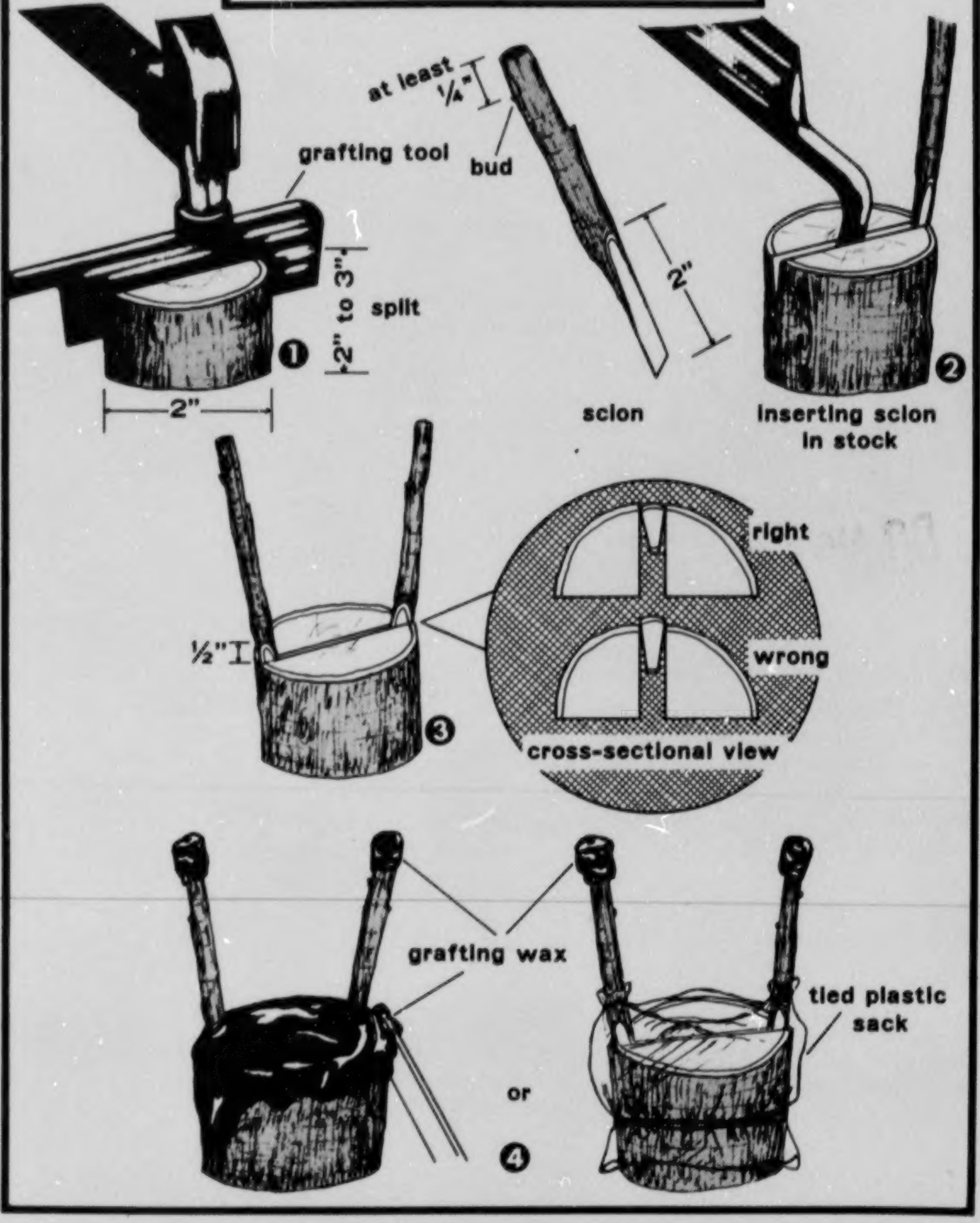
REFERENCES:

1. "Budding and Grafting Fruit Trees," Michigan Extension Service, B508, 1965.

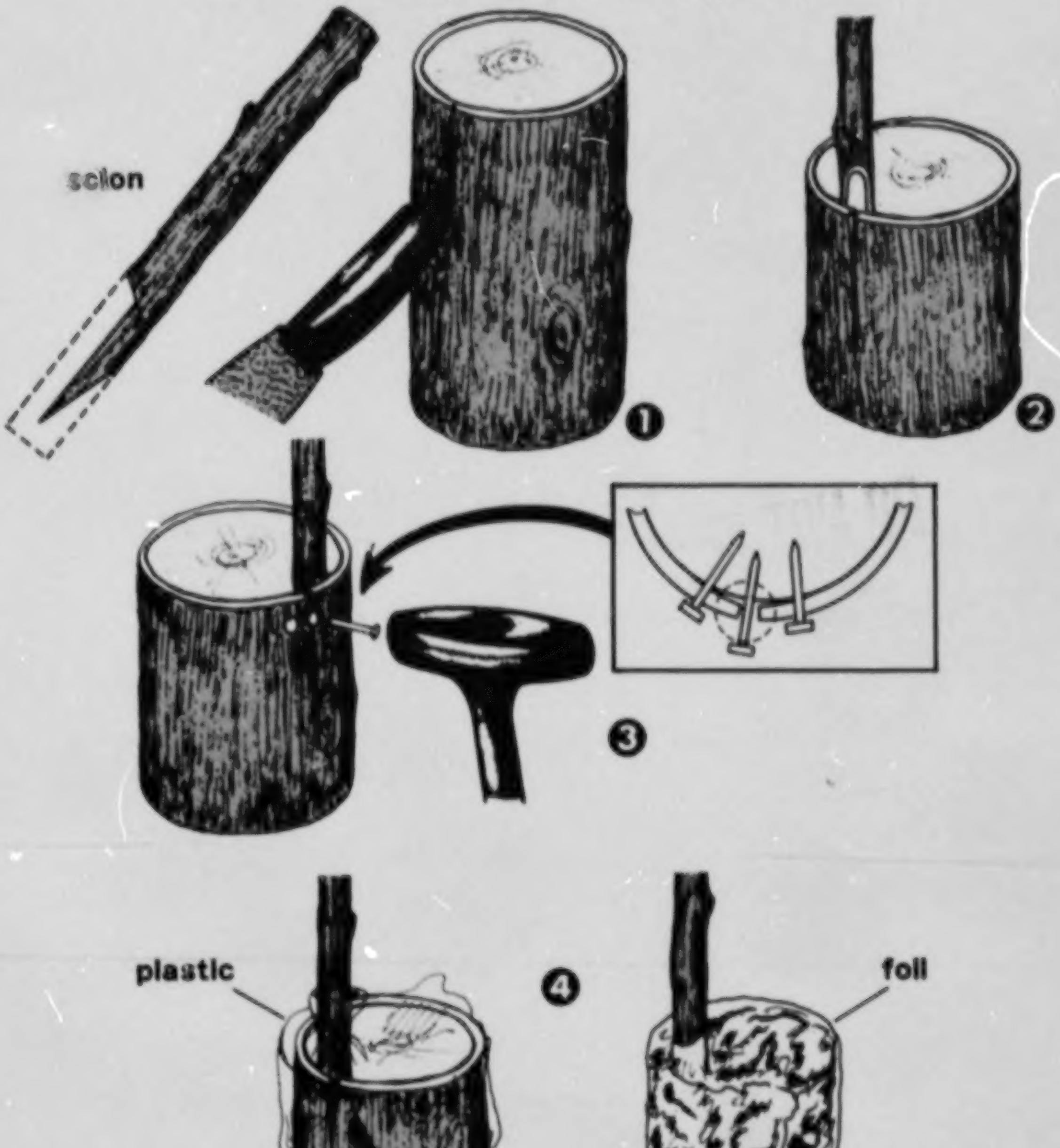
2. "Propagating Horticultural Plants," Vocational Instructional Services, Texas A&M University, 1969.

3. "Basic Gardening Illustrated," Lane Books, Menlo Park, California, 1970.

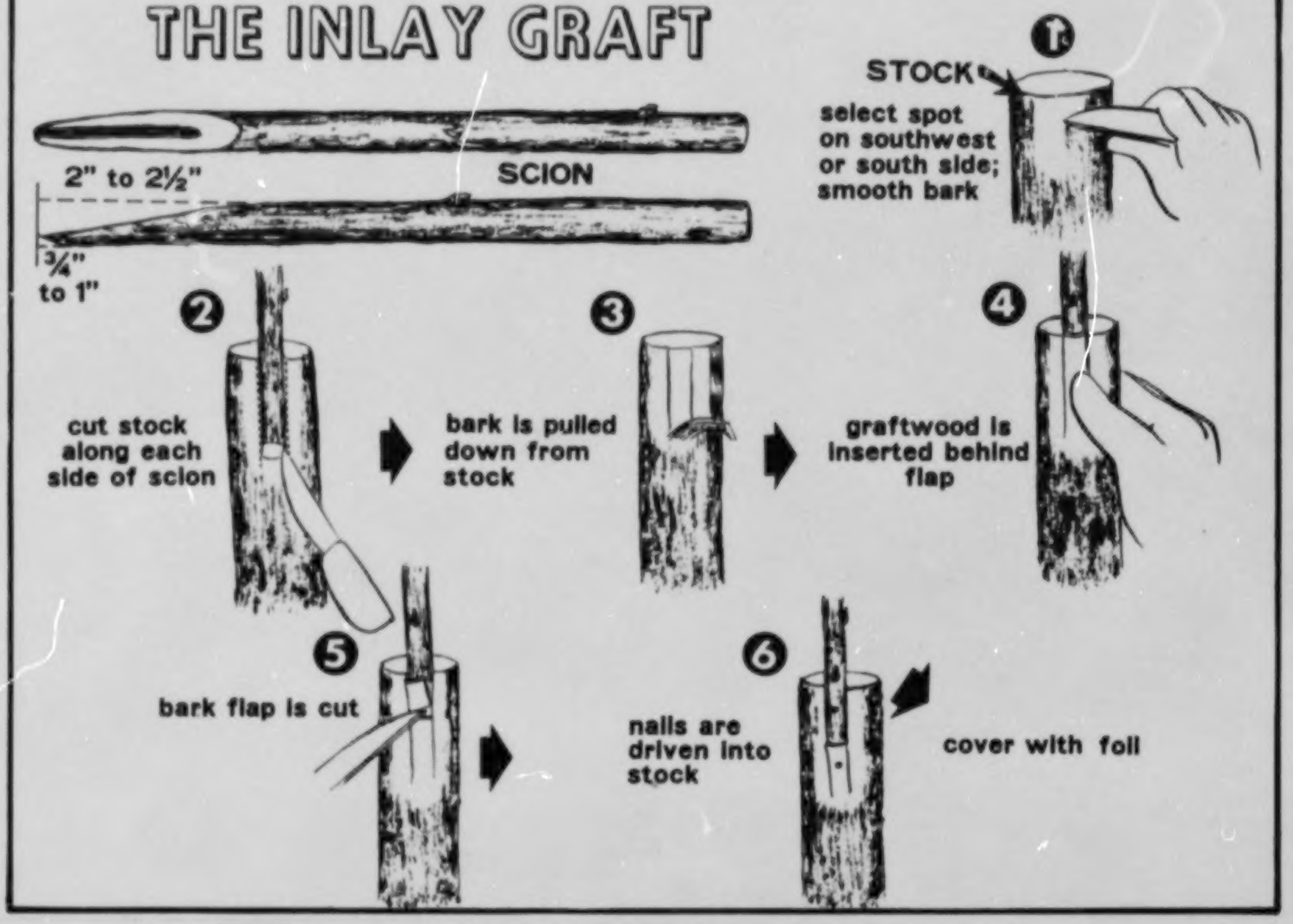
THE CLEFT GRAFT


grafting tool
2" to 3"
split
2"
❶
at least
¼"
bud
2"
scion
❷
inserting scion in stock
½"
❸
right
wrong
cross-sectional view
grafting wax
or
tied plastic sack
❹

THE BARK GRAFT


scion
❶
❷
❸
plastic
❹
foil

THE INLAY GRAFT



1. select spot on southwest or south side; smooth bark

2. cut stock along each side of scion

3. bark is pulled down from stock

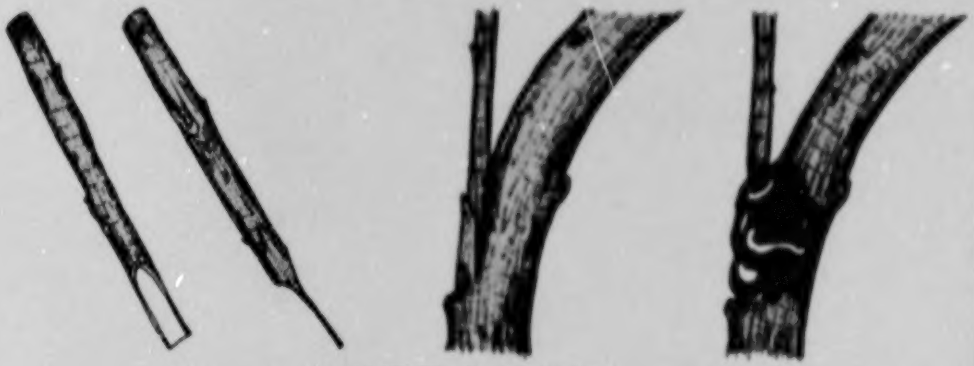
4. graftwood is inserted behind flap

5. bark flap is cut

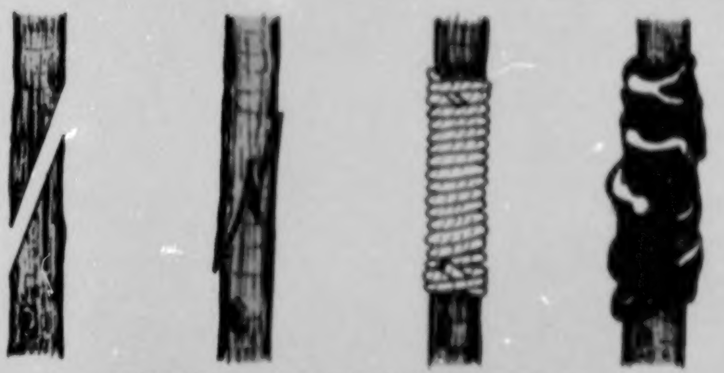
6. nails are driven into stock

cover with foil

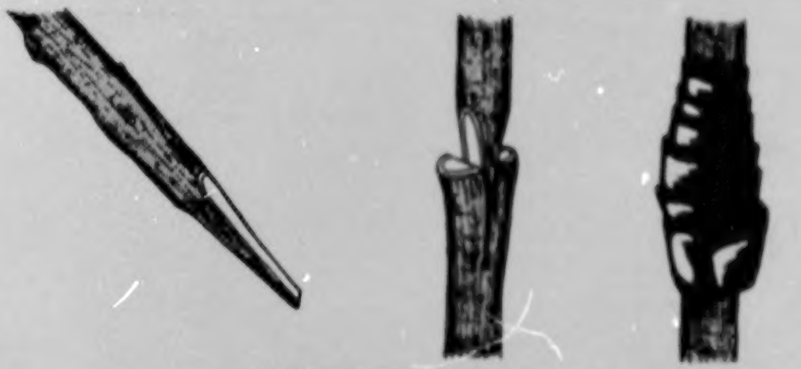
GRAFTS



SIDE GRAFT

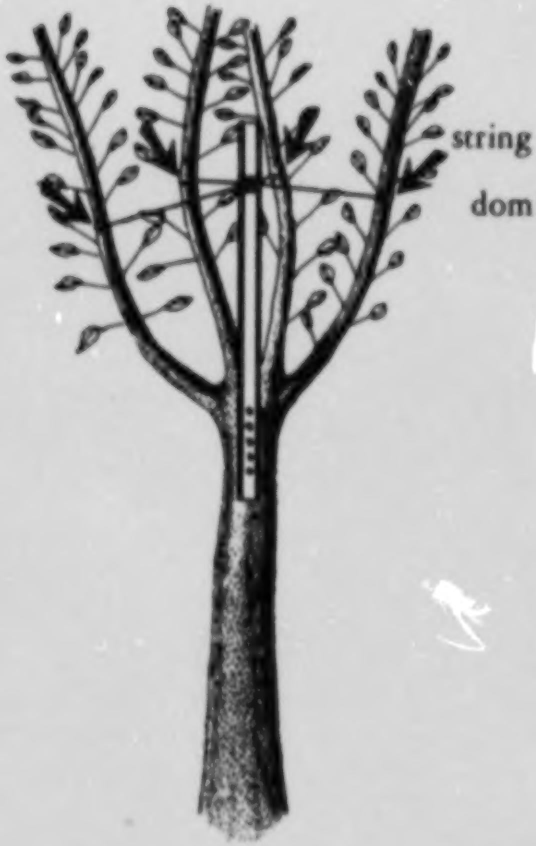


WHIP or TONGUE GRAFT

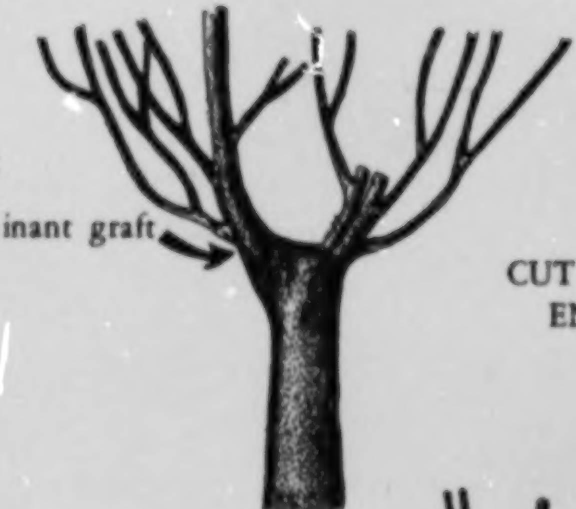


WEDGE GRAFT

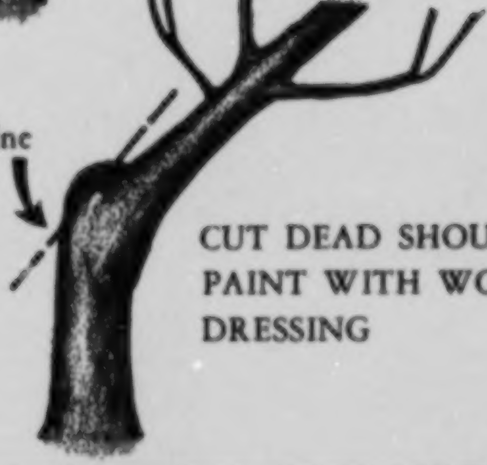
CARING FOR THE GRAFTS



LATH NAILED TO STOCK


dominant graft

CUT OTHERS BACK AT
END OF FIRST YEAR


cut on dotted line

CUT DEAD SHOULDER
PAINT WITH WOUND
DRESSING

Vocational Instructional Services
Agricultural Education

F-6
Agdex . 30/30 x 200

CVAE AND VEH HORTICULTURE

Unit F: Propagation of Plants

Topic 6: Propagating Plants By Budding

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

It is suggested that the information in this topic be presented while demonstrating the different kinds of budding.

1. Introduction:

Budding is a form of grafting. A scion having a single bud is applied in its normal position to the cambium of the stock. There are two advantages to budding over grafting: (1) a bud will not disfigure a seedling if it does not grow, and (2) budding can be done over a much longer period of time. Buds can be applied any time after the bark begins to slip, but usually the best time is in the early spring (April 15 to May 15).

Two kinds of budwood may be used: (1) current season, and (2) previous season. Current season budwood is wood that developed during the season in which it is used, which is normally in the late summer. Previous season budwood is cut while the wood is dormant (January or February) and is stored at about 37 degrees F. until needed.

In the selection of budwood for storage, round, firm branches about one-half inch in diameter are the ideal size. The budwood is cut 8 to 10 inches in length, placed in moist sphagnum moss, wrapped in plastic, and stored at 37 degrees F. The package should be air-tight to prevent the evaporation of moisture. This prevents the budwood from drying out. A few days before the budwood is to be used it is removed from the refrigerator. The bark must slip on the budwood.

After the buds begin to grow, the branches above the bud are usually cut off. The care of the growing bud is similar to the care given a graft, which is discussed in the preceding topic.

The three most widely used methods of budding are discussed in the following paragraphs.

2. Propagating Plants by Patch Budding

The patch bud is used to bud ornamental plants and fruit and nut trees. It is primarily used on plants that have thick bark.

There are several variations of patch budding, but they are all basically the same. Some of the variations are I-bud, flute bud, and ring bud. The I-bud is made by splitting the bark on the stock in the shape of an "T" and inserting the patch beneath the two flaps. The ring bud is made by removing a one-eighth inch ring of bark from the stock, and a similar patch is removed from the scion and placed on the stock. To make a ring bud, the propagator removes a full ring of bark from the stock, and a bud patch of the same size and shape taken from the budwood replaces it.

Transparency No. 1

To make the patch bud, the propagator uses a two-bladed knife to cut two parallel cuts perpendicular to the stock at a smooth place between two nodes. The cuts are approximately one inch apart. A longitudinal cut is made through the bark at one end of the horizontal cuts.

Similar horizontal cuts are made on each side of a bud on the budwood, and longitudinal cuts are made on each side of the bud on the budwood. The point of a knife blade is used to peel the bark back on the stock.

Using the point of the knife, the propagator lifts the bud from the budwood. The bud is placed on the stock as quickly as possible to prevent it from drying out. The flap on the stock is lifted, and the bud is placed on the stock in a natural position. If the double-bladed knife was used properly, the bud should fit snugly into the area cut for the new bud.

The flap of bark on the stock is placed on the edge of the bud and cut off as closely to the edge of the bud as is possible. A maximum amount of the cambium on both the stock and scion should be in contact. A piece of plastic that has a hole to expose the bud is placed over the bud and drawn tight around the limb. Rubber strips are used to secure the bud to the stock and seal the plastic. The bud should not be covered with the strips. String and grafting wax also may be used to secure and seal the bud. Care should be taken not to cover the bud with the string and wax.

3. Propagating Plants by T-Budding

T-budding is sometimes referred to as shield budding and is the easiest bud to apply. The best results have been obtained on stock of one-third to one-half inch in diameter.

Transparencies No. 2A & 2B

T-buds are made by cutting a one-inch long vertical cut through the bark of the stock. Then a horizontal cut about one-third the diameter of the stock is made at the top of the vertical cut. The corners of bark at the top of the "T" are raised with the point of the knife blade.

The bud is cut from the budstock by cutting under the bark and bud. The cut should start one-half inch below the bud and extend about one inch above the bud A three-quarter inch horizontal cut is made at the top of the bud, and the shield-shaped bud is pushed sideways to remove it from the budstock. The wood core is left in the bud.

The bud is pushed down into the T-cut on the stock from the top until the top of the shield-shaped bud is even with the horizontal cut of the T. The bud then is wrapped with either of the means previously described.

4. Propagating Plants by Chip Budding

Chip budding is done during the dormant season and when other types of buds cannot be applied. It is slower and not as simple as T-budding.

Transparency No. 3

In the process of chip budding, a chip of bark is removed from a smooth area between the nodes on the stock, and a similar chip containing one bud is taken from the budwood and placed on the stock. Both cuts should be cut as nearly alike as possible, and care should be taken to make sure the cambiums are in contact. After the bud is inserted, it should be tied with string or tape and covered with grafting wax. After the bud begins to grow, it is cared for in the same manner as a graft. The limb above the bud is usually cut.

LABORATORY EXERCISE

Activity: Demonstrate patch budding, T-budding, and chip budding

Materials:

Stock on which to place buds
Budding tools (two-bladed knife, pocket knife,
  and pruning shears)
Plastic
Grafting wax
Ties

Procedure:
The procedure to follow is explained in the topic.

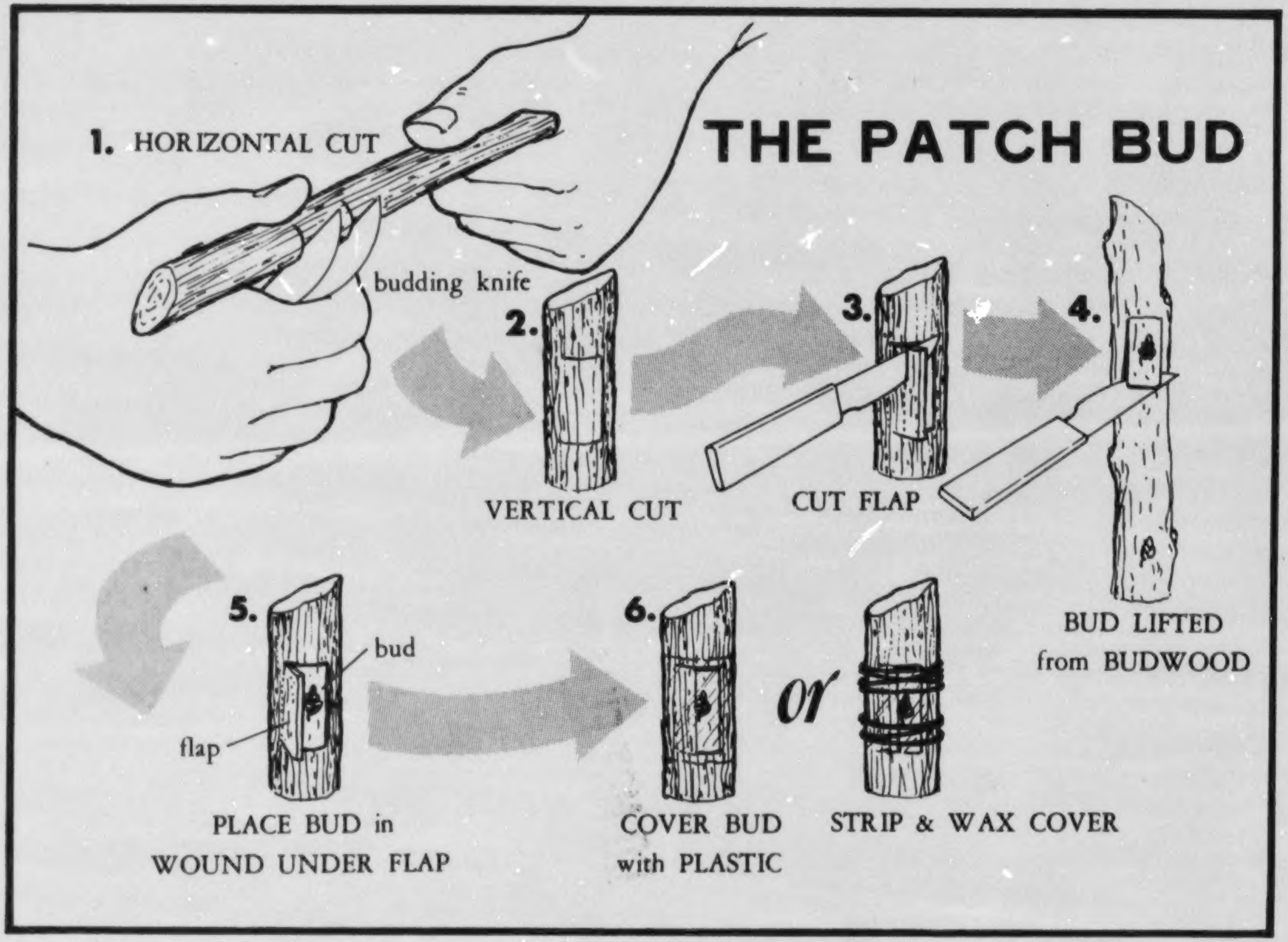
REFERENCES:

1. "Ornamental Horticulture Plant Propagation: Asexual and Sexual Reproduction," Virginia Polytechnic Institute and State University, Blacksburg, VA., 1971.

2. "Basic Gardening Illustrated," Lane Books, Menlo Park, CA., 1970

3. "Propagating Horticulture Plants," Vocational Instructional Services, Texas A&M University, College Station, TX., 1969.

THE PATCH BUD



1. HORIZONTAL CUT

2. VERTICAL CUT

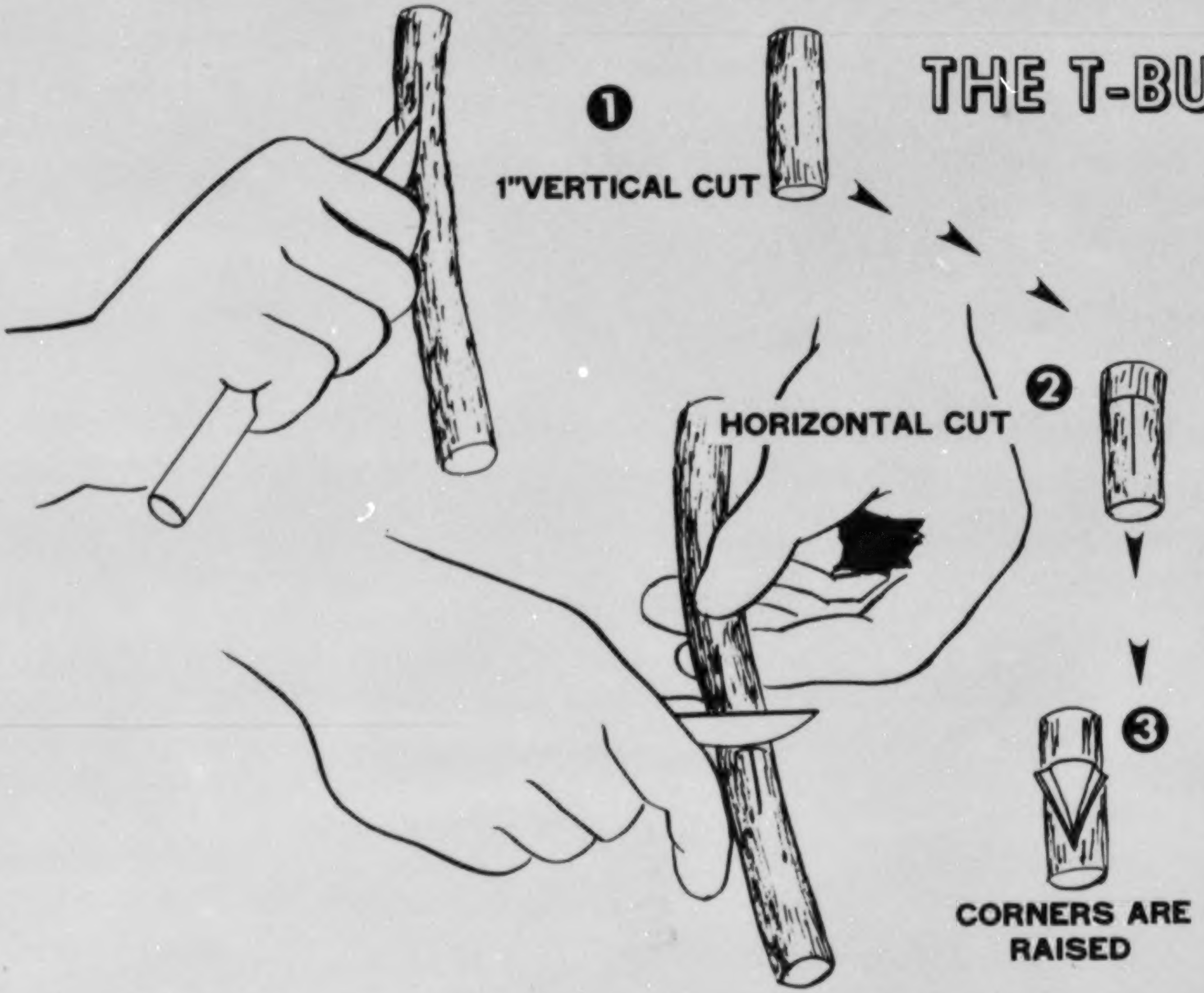
3. CUT FLAP

4. BUD LIFTED from BUDWOOD

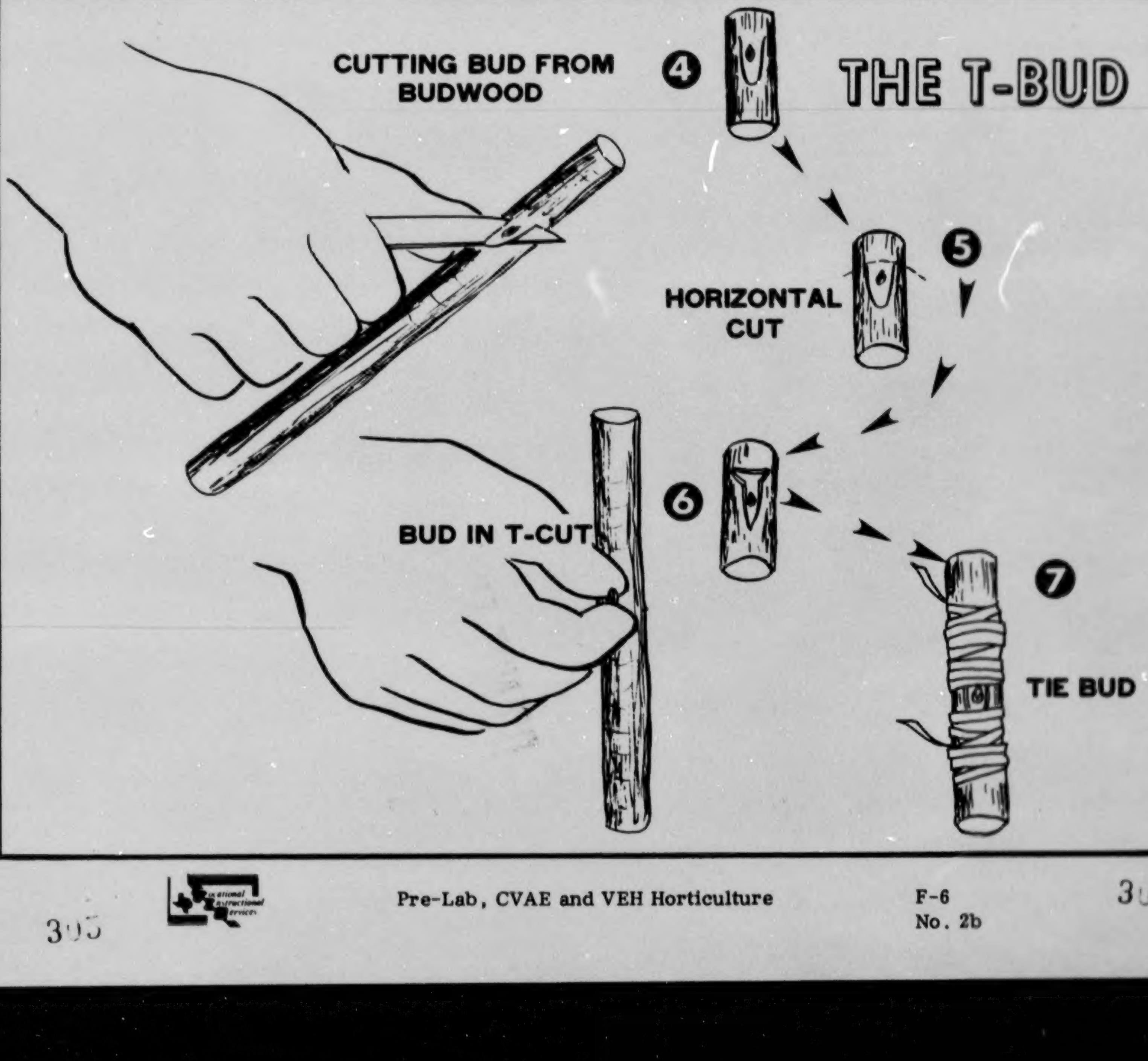
5. PLACE BUD in WOUND UNDER FLAP

6. COVER BUD with PLASTIC *or* STRIP & WAX COVER

THE T-BUD

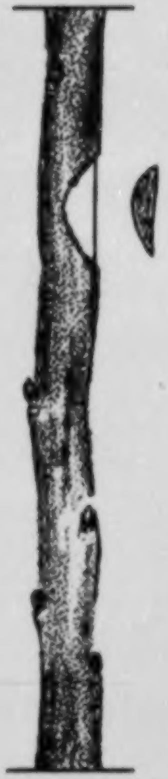

❶
1"VERTICAL CUT
❷
HORIZONTAL CUT
❸
CORNERS ARE RAISED

THE T-BUD


CUTTING BUD FROM BUDWOOD
4
5
HORIZONTAL CUT
6
BUD IN T-CUT
7
TIE BUD

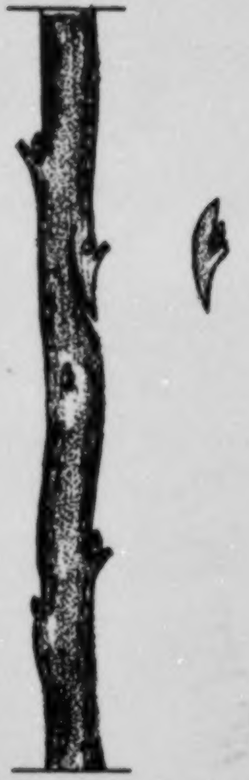
THE CHIP BUD

①



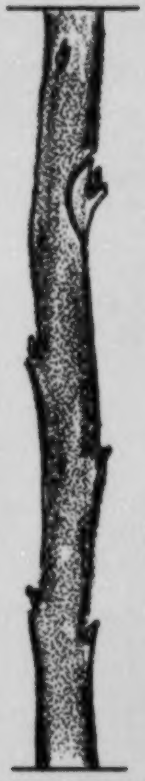
REMOVE CHIP OF BARK THE SIZE OF A BUD CUTTING

②



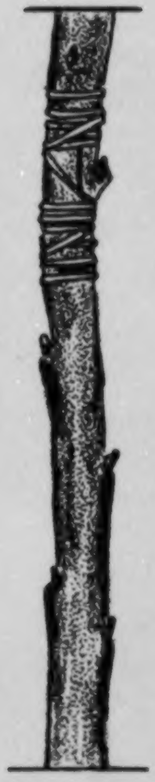
CUT BUD & REMOVE FROM BUDWOOD

③



TRANSFER TO BARED SPOT (1)

④



TIE WITH STRING. WAX

CVAE AND VEH HORTICULTURE

Unit F: Propagation of Plants

Topic 7: Plant Selection and Breeding

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

The teacher may desire to review the parts of a flower, topic F-1, transparency No. 2, and discuss complete, composite, and imperfect flowers before beginning this topic.

1. Introduction

Ornamental plants found growing in Texas are classified as (1) native and (2) introduced. Native plants are those that were found growing in a natural state (wild), while introduced plants are those that have been imported from other states and countries. The first introduced plants were brought to this country by the colonists.

In the early history of this country, wealthy landowners imported ornamental plants from Europe to enhance the beauty of their estates. Some of the imported plants did not survive, but a number of them grew and beautified the spacious gardens. H.H. Hunnell of Massachusetts imported over 2,000 forest trees, ornamental plants, and fruit trees in 1847. The first importation of plants by the USDA was in 1898. Although the chief interest at this time was plants of economic importance, ornamentals were not overlooked. Since this time, plant explorers from the United States have covered the earth collecting plants for introduction into this country.

After spending several years of breeding and propagating plants, horticulturists introduce them to the public. Eventually, these plants will be found in a large area.

2. Plant Selection

Through selection the characteristics of plants can be changed over a long period of time. Few plants today resemble their wild ancestors.

Breeders of horticultural plants use two methods in selecting plants, (1) natural and (2) artificial. Natural selection is the process that occurs in nature whereby strong, well-adapted plants survive and grow. Weak, poorly-adapted plants eventually die. Natural selection has been in progress since the beginning of time. Artificial selection is the selection of plants for one or more characteristics.

3. Heredity of Plants

Both animals and plants inherit characteristics from their parents. The laws of heredity provide an explanation of why different traits are inherited. They also make it possible to predict the number of offsprings that will inherit a certain trait. A knowledge of genetics is essential for a plant breeder.

All plants and animals have genes in their cells. The genes determine the traits that are inherited. For example, a plant flower could have one gene for yellow color and one for red. When the female and male germ cells unite in the ovule, each contributes one gene for each trait. The new seed has two genes for each trait.

It is impossible to tell from looking at a plant exactly what genes it contains. However, by observing the offsprings for several generations, the breeder can determine the genes of the parent plants.

Transparency No. 1

The interaction of genes can be explained in the following example and above transparency. Assume that two true-breeding plants (one having two genes for red-colored flowers and the other having two genes for yellow-colored flowers) are crossed. The offsprings from this cross are called the first filial or F_1 generation. Illustration No. 1 in the above transparency shows the ways in which the genes of the pollen parent can combine with those of the seed parent. Each square represents one seed. The letter R represents the gene for red color and the letter r represents the gene for yellow color. Each F_1 plant will inherit a gene for red from one parent and gene for yellow from the other parent.

Genes from F_1 self-pollinated plants can combine in four different ways. The four possible combinations are shown in illustration No. 2. Offsprings produced from the self-pollinated F_1 generation are called the second filial or F_2 generation.

From every four seeds produced, a breeder can expect one seed with two genes for red and one gene for yellow (Rr), and one seed with two genes for yellow (rr). The above ratio is based on the probability for large numbers and may vary if a small number of seeds are used.

A seed containing two genes for the same color is said to be pure for that trait. The flower produced from this seed will be that color. For example, the seeds containing two genes for red color (RR) will produce red flowers, and the seeds containing two genes for yellow (rr) will produce yellow flowers. Seeds containing genes for both colors (Rr) may produce flowers that are red, or flowers that are mauve (a shade halfway between red and yellow). This will depend on whether the gene for red has complete or incomplete dominance.

Some genes are dominant, while others are recessive. Whenever a dominant and a recessive gene for a particular trait occur in the same plant, the characteristic of the dominant gene will be shown in the plant.

Fixing a Trait

It is usually necessary that plants be allowed to cross - pollinate in order to develop new varieties. Once a trait is fixed in the self-pollinated plant (breed true for the trait), the trait may be maintained by allowing the plant and its offspring to self-pollinate. Some traits cannot be fixed.

The following explanation is provided to illustrate how a breeder would fix a trait by self - pollinating plants in the F_2 generation in three different situations. These are as follows: (1) breed only yellow flowers, (2) breed only red flowers, and (3) breed only mauve flowers.

As previously explained, one may expect one out of every four flowers to be yellow (rr), whether there is complete or incomplete dominance. The yellow flowers would be pure since they would not have R genes. They may be sold as yellow flowering plants and will breed true.

If red is the dominant gene, the F_2 generation will produce three red flowers out of four; some of the red flowers will contain Rr genes and some will contain RR genes. Since the plants containing the RR genes will breed true, the plants with these genes must be isolated. Allowing plants with the Rr genes to self-pollinate would produce both red and yellow offspring. The self-pollinated parents that produce both red and yellow offspring can be discarded as they are obviously the ones containing Rr, but the parents that produce red offsprings have bred true.

Mauve flowers are produced when red has incomplete dominance over yellow In the F_2 generation, if there is incomplete dominance, two out of every four flowers will be mauve. When these flowers are self-pollinated, segregation will occur, and they will produce flower colors in the same ratio as was produced in the F_2 generation (1:2:1). The color in mauve cannot be fixed.

The discussion up to this point has dealt with the breeding of one trait. After observing plants and their traits, a breeder can determine if the trait has complete or incomplete dominance. A 3:1 ratio in the F_2 generation usually indicates complete dominance; a 1:2:1 ratio incomplete dominance. Then one can tell whether or not it is possible to fix a trait.

A breeder may wish to breed for more than one trait. With two genes for each trait in each parent, many offspring will have to be grown before one will appear with all the desired traits. Traits that are relatively easy to change are yield, flower color, plant size, leaf size, fruit shape, and fruit size.

F_1 hybrids of vegetables and flowers are often advertised. These varieties are the results of crosses between two purebred lines. The purpose of crossbreeding is to produce a plant with the desirable traits possessed separately by the parent plants. Characteristics often obtained by crossing two pure lines are increased vigor, uniformity, and earliness. To maintain the desirable characteristics of the hybrid, the original parents are crossed each year.

4. Breeding Techniques

The equipment required for plant breeding is relatively inexpensive and easy to use. The following items may be useful:

- Magnifying glass (10 or 15 power)
- Tweezers
- Small sharp-pointed scissors
- Camel-hair brush
- Small containers or vials
- Alcohol
- Rubber bands or soft wire
- Paper or cellophane bags
- Paper clips
- Tags
- Notebook

Prepollination steps generally should begin just before the flower opens. Waiting until after it opens may cause it to pollinate by natural means, which would make the flower useless for experimentation. Since most plants bloom over a period of time, even if some of the flowers on a plant have bloomed before being prepared for breeding, there will probably be others that haven't opened yet and that can still be used in the experiment.

The first step in prepollination is to mark the flowers that are to serve as pollen parents and those that are to serve as seed parents. This can be accomplished by labeling the plants with plastic labels or some other means.

Step two is to protect the plants from unwanted pollen. If the plant is to be cross-pollinated, the stamens will have to be removed to prevent the possibility of self-pollinating. The stamen should be removed before the anthers split open to release pollen. This may require the opening of the flower by hand before it is ready to bloom.

Transparency No. 2

Removing the stamens or anthers is called emasculation. Removal may be accomplished in several ways: (1) pinching off the stamens or anthers with tweezers (ill. No. 1), (2) snipping off the stamens or anthers with sharp-pointed scissors, and (3) removing the petals to which the stamens are sometimes attached. A magnifying glass will be particularly useful in emasculation.

Both the seed and pollen parents should be protected from contamination by foreign pollen. This can be done by one of the following methods: (1) in flowers such as morning-glories, petunias, and lilies, the petals can be closed around the floral organs with a piece of wire, soft string, or rubber band (ill. No. 2). Care should be taken not to tear the petals. (2) Since some flowers cannot be closed, they are protected by covering the flower with a paper or cellophane bag. The bag is secured in place with a string or paper clip. (ill. No. 3).

Pollination Steps

Several methods may be used for cross-pollinating flowers. Four common methods are given below:

1. Stamens are removed from the pollen parent with tweezers and placed in a container. The protector is removed from the seed parent. A stamen is held with tweezers, and the anther is gently brushed across the stigma (ill. No. 4). The protector is replaced.
2. The flower serving as the pollen parent is cut and the protector is removed from the seed parent. Tweezers are used to remove a stamen from the pollen parent, and the anther is brushed gently across the stigma of the seed parent. The protector is replaced.
3. Using a camel-hair brush, the pollen is transferred from the anthers of the pollen parent into a small container. The protector is removed from the seed parent and the pollen is brushed across the stigma (ill. No. 5). The protector is replaced.
4. The bagged pollen parent is shaken so that the pollen is collected in the bag that is covering it for protection. The bag is removed from the pollen parent, and care should be taken not to spill the pollen. The protector is removed from the seed parent, the bag containing the pollen is placed over the seed parent, and the bag is shaken so that the pollen falls on the stigmatic surfaces. This is usually done on corn.

Each time different pollen is used, the breeder should be sure to first wash with alcohol the camel - hair brush, tweezers, and any other item which might have touched some pollen. This step is very important to prevent pollination of the seed parent with unwanted pollen that has adhered to the equipment. After the instruments are washed, they should be dried before using again.

Procedures for self-pollinating flowers will depend on the type of flower. For perfect flowers, (flowers having both stamens and pistil), the job is completed once the flower is closed or covered, although sometimes the pollen can be helped to land on the stigma by shaking the flower once a day for several days after the pollen develops.

Only those composite flowers (a cluster of small flowers) containing both disc and ray florets can be self-pollinated. Since they have both pistils and stamens, they can be selfed in the same way as perfect flowers.

With imperfect flowers, (flowers having only one sex organ), you will be able to self-pollinate only those flowers that are on the same plant. In selfing imperfect flowers, the pollen from the staminate flower must be transferred to the stigma of the pistillate flower on the same plant. To do this you can use any of the methods given above for cross pollination.

Postpollination Steps

Immediately after pollination, close or cover the flower again. The next step is to label the seed parent. The standard method of labeling is as follows:

1. Write on the label in the following order: (a) the number that you have assigned or the variety name of the seed parent; (b) the letter X; (c) the number or variety name of the pollen parent; and the date the cross was made.
2. Attach the label to the stem just below the flower that has been pollinated.

Once the seed parent is labeled, the next step is to record the cross or self in a notebook. Keeping complete and accurate records of the breeding operation is very important. The information that is recorded should contain all essential facts regarding the cross or self so that one can refer to it at a later time and even do the job again from the beginning if necessary.

A separate form or page should be used for each cross or self that is made. An easy way to keep track of the offspring is to assign consecutive numbers to each generation resulting from each cross or self.

Suggested Form for Keeping Records

Kind of Plant________________________

Seed parent________________________ (name or no.) Pollen Parent____________________ (name or no.)

Date cross made________________ No. to be assigned offspring____________

Traits of seed parent____

Traits of pollen parent_______________________________________

Traits desired of offspring___________________________________

Offspring notes:

Date planted	Date of first flowering	Traits			Date of pollination		Harvesting information	
		Size	Color	Etc.	First	Last	Date	No. of seed

After the plants have been pollinated, a period of time is required for fertilization and development of the ovule. When the seed has developed, it should be harvested. The seeds should be harvested in plants grown for flowers when the seed pod becomes dry or when it begins to split open. The seeds of fruits and vegetables are ready for harvesting when the seed-bearing parts have reached maturity.

When the seeds are harvested, they should be placed in packets and the packet labeled. The label should bear the offspring number. The seeds should be planted as soon as practicable and the results recorded.

Most of the information for this topic was taken from "Plant Breeding as a Hobby," Illinois Extension Circular 817.

LABORATORY EXERCISE

Activity: Breeding Experiment

Most any ornamental plant or field crop that has a short life cycle may be used. Corn is used in the explanation of the procedure, because it is a good plant for the amateur plant breeder to experiment with.

Materials:

Seed corn
Plastic bags
String or paper clips

Procedure:

1. Plant the corn seeds that are being crossed in the experimental seed plot.
2. As soon as the plants develop ear shoots and before the silks emerge, the shoots should be covered with a loosely fitted plastic bag secured at the bottom with a paper clip or string.
3. The ears should be observed closely, for the ear is ready for pollination when the silks are visible.
4. The appropriate tassels should be bagged for use. The bag should be secured tightly at the base of the tassel to keep the pollen from falling out and to keep it from becoming contaminated with other pollen.
5. The following morning, the bagged tassels should be shaken vigorously to loosen the pollen. The bag is removed from the tassel by bending the tassel downward to prevent pollen from spilling out.

6. The bag covering the silks is removed, and the bag containing the pollen is placed over the ear, secured to the stalk below the ear, and is shaken. The bags are left on the ears until the leaves of the plant dry.

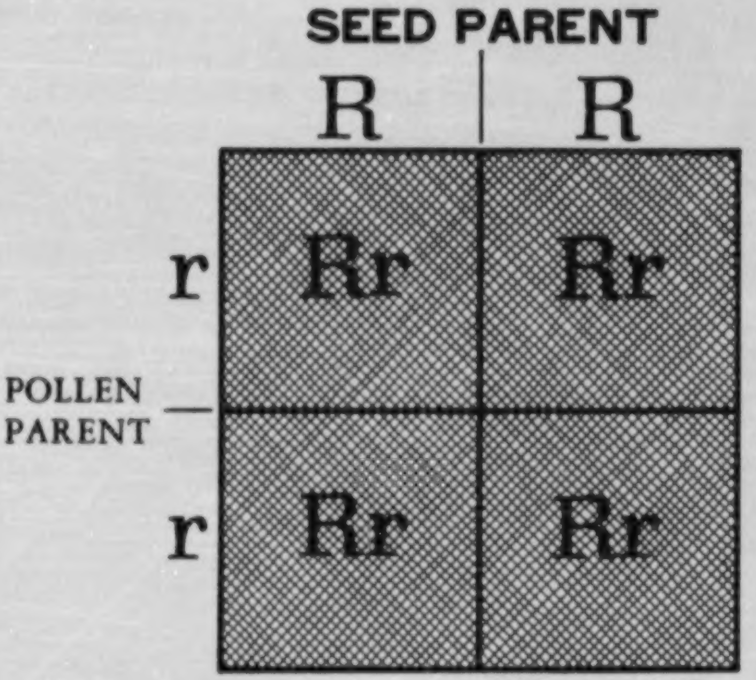
7. Each ear should be labeled. The label should contain the name or number of the plants that are serving as seed and pollen parents.

REFERENCES:

1. "Plant Breeding as a Hobby," Illinois Extension Service Circular 817.

2. Seeds, 1961 Yearbook of Agriculture, U.S. Departmeht of Agriculture, Washington, DC.

PLANT HEREDITY

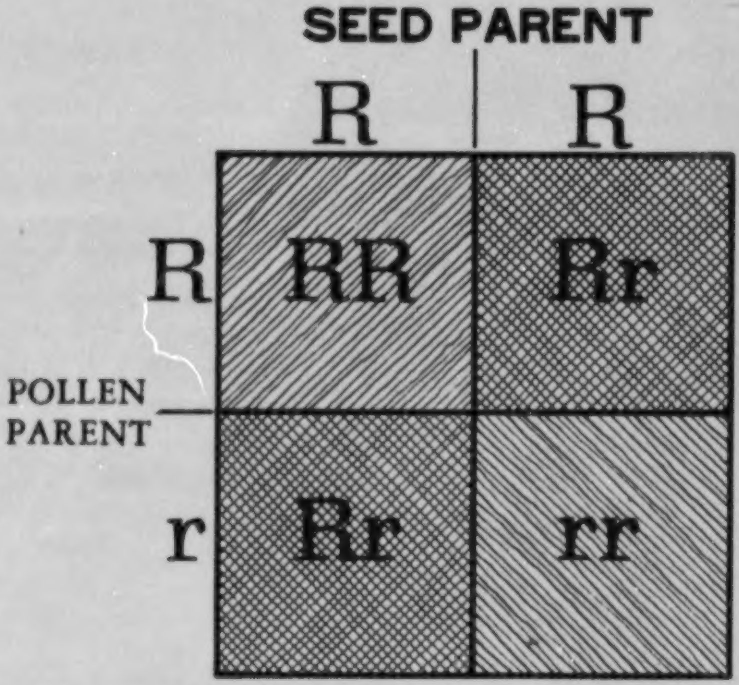


SEED PARENT

POLLEN PARENT

	R	R
r	Rr	Rr
r	Rr	Rr

ILL. NO. 1



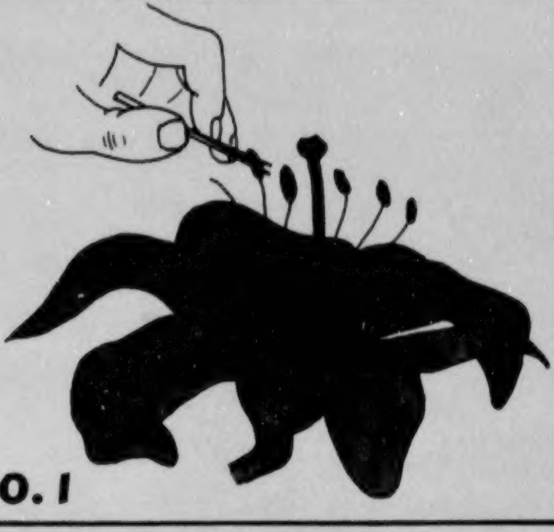
SEED PARENT

POLLEN PARENT

	R	R
R	RR	Rr
r	Rr	rr

ILL. NO. 2

EMASCULATION OF THE STAMEN



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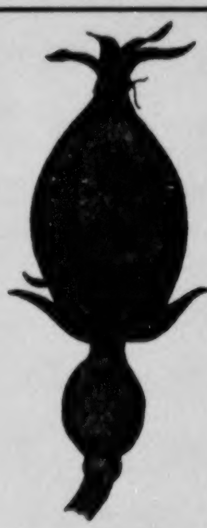

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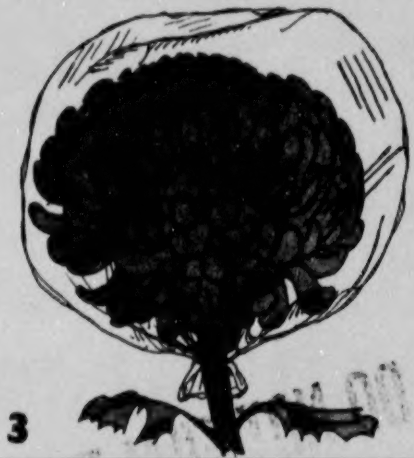

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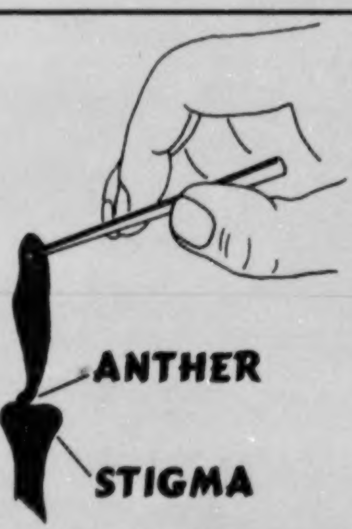
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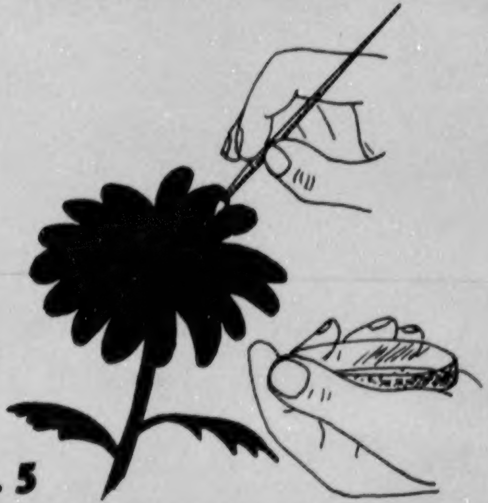
STIGMA

NO. 4



NO. 5

Vocational Instructional Services
Agricultural Education

G-1
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit G: Growing Greenhouse Plants

Topic 1: Cut Flower Production

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction

The first cut flowers were produced in the Philadelphia, Pennsylvania area. In the early part of the nineteenth century, this area was the social center of the United States. This is probably the reason that most of the cut flowers are still produced in the northeast. Cut flowers were first produced outdoors and were of poor quality. As the demand increased, growers developed varieties that produced high quality flowers and that were adapted to greenhouse production.

Based on a survey conducted in 1976 by the Statistical Reporting Service, USDA, the sales of flowers and foliage plants have increased considerably in the last few years. The wholesale value of standard and miniature carnations amounted to $512 million. During the same year, standard, pompon, and potted chrysanthemums sales by growers were $116.4 million.

Commercial cut flowers are grown in narrow ground or low benches (3 1/2 to 4 ft. wide). This size bench makes the benches easier to work and gives the plant more head room for growth. Well-drained, coarse media with a high humus content is used for cut flower production. The benches are filled so that after the media settles it is within one inch of the top of the sides. The media is allowed to remain in the benches for several years, but is sterilized before planting each new crop.

Two methods are used to apply fertilizers to cut flowers. If an injector system is available, the fertilizer is applied as the plants are watered. Otherwise, it is incorporated into the soil before planting. Rate of fertilizer application is based on a soil test. A ph test should be conducted of the media to make sure the soil ph is correct for the crop to be grown.

The rule of thumb for watering cut flowers is one-half gallon of water per square foot of soil. However, enough water should be applied to permit drainage through the soil. A method that may be used to determine when to water is to dig to a depth of two inches in several places in the media. If the media is dry at this depth, the plants need water. The soil should be allowed to dry between waterings.

2. Producing Chrysanthemum Cut Flowers

Chrysanthemums are sold both as cut flowers and potted plants. There is one principal difference between the two. Cut flowers are grown with long stems (about 30 inches long), while potted plants are grown with short stems. Long stems are produced by growing the plants vegetatively for a long period of time before allowing them to set flowers.

Transparency No. 1

Chrysanthemums are classified according to the kind and arrangement of florets. (parts of the flower). Six kinds are included in the above transparency and are discussed.
Incurved - The curving of the petals forms a globular flower. These are large flowering varieties which have flower arrangements similar to the pompons.
Decorative - This type is also similar to the pompon, but the flower parts have a flat appearance caused by the ray florets (distinct petals) being longer than the inner ones.
Pompons - The ray florets form a ball-shaped flower and hide the disk florets (short petals).
Single - Flowers of this kind have one or several rows of ray florets and disk florets in the center.
Anemone - The florets are similar to the single, but the center florets form a cushion and display a tubular shape. The center florets are more developed.
Spider - This type has tubular ray florets. The outer florets are usually longer than the inner ones.

Transparency No. 2

There are four different groups of chrysanthemum cut flowers. A discussion of each is given.
Standard - This group includes all of the large - flowering types. All lateral buds are removed, and usually only one flower is produced on a stem. Some growers, however, may prune for two stems. The flowers should be four to six inches in diameter.
Disbud - Any spray - type that is grown with all lateral flower buds removed is a disbud. They are grown in a similar manner as the standards, but the flower is smaller and stem is shorter.
Disspray - This is any spray - type with the central flower buds removed to improve the spray formation.
Spray - Included in this group are the spray-types (pompon, anemone, decorative, etc.) grown without removing any of the flower buds. There are several flowers to the stem. The pompon type flower is the most often used when producing this group.

The spacing of chrysanthemums in the bed affects the size of bloom, spray form, weight, and strength of stem. The spacing of the cuttings is of utmost importance. Plants spaced too close will produce small, weak flowers; and too much space is uneconomical. Tall crops will need more space than low growing crops. The following spacing is recommended for the different groups:

Single Stem	Crop to Flower	Spacing
Pompons	April 15 - November 1	4" x 6"
	November 1 - April 15	4' x 6"
Standards	April 15 - November 1	5" x 6"
	November 1 - April 15	6" x 6"
Disbuds	April 15 - November 1	4" x 6"
	November 1 - April 15	4" x 7"

Pinched	Crop to Flower	Spacing
Pompons	April 15 - November 1	7" x 7"
	November 1 - April 15	7" x 8"
Standards	April 15 - November 1	7" x 8"
	November 1 - April 15	8" x 8"
Disbuds	April 15 - November 1	7" x 7"
	November 1 - April 15	7" x 8"

Chrysanthemums are planted in beds as root cuttings, which are usually purchased from a propagator specializing in their production. To prevent shocking cuttings that have been held at a low temperature, the grower should store them at room temperature for twelve hours before planting them in the bed.

Transparency No. 3

Chrysanthemums should be planted as shallow as possible to prevent the roots of the cuttings from rotting. If they are planted at the proper depth, the first watering may cause some of the cuttings to list and have to be straightened. It may be necessary to cover the cuttings with a mist several times the first few days they are planted.

Caring for Chrysanthemums

It is difficult for the inexperienced producer to determine when to water chrysanthemums. Even though they have the highest water requirement of any cut flower and must be watered as often as twice a day during the summer the time to water is a crucial factor. The water requirements increase as the plant grows.

The temperature requirements of chrysanthemums are also important in their production because of the relatively narrow range. The recommended temperature is 70° - 72° F., and a nighttime temperature of 62° - 65° F. is recommended. A temperature below 60°F. may prevent buds from forming, and a temperature above 80°F. will prevent or delay flowering.

The length of time required to produce cut flowers is dependent upon how they are handled, but usually cut flowers can be produced in from three to five months. Flowering is controlled by the length of the day. Leaves and stems develop when the plant is allowed to receive several hours of daylight, and buds develop when the plant receives less daylight. Flower color and petal burn are also controlled by regulating the length of daylight and light intensity A black cloth is used to regulate the number of daylight hours.

To produce the desired type of flower and make the plant branch the producer pinches the plant. As little as possible of the tip of the new growth is removed when pinching. Normally, several shoots develop after the plant is pinched, but all but the two strongest ones are pruned. However, the plants on the outside rows may be left with the three branches, since these rows receive more light.

Some type of support must be furnished for the chrysanthemums. Welded wire with a 6" x 8" spacing is probably the best support that may be used. The support is used for the upper part of the plant, and it may be necessary to provide two different supports if all of the plants are not the same height.

Grading and Bunching

Standardized grades other than those suggested by the Society of American Florists have not been established for chrysanthemums. The suggested standards are as follows:

	Blue Grade	Red Grade	Green Grade	Yellow Grade
Minimum Flower Diameter	5-1/2"	4-3/4"	4"	3-1/4"
Minimum Stem Length	30"	30"	24"	18"

Insects and Diseases

In order to successfully produce cut flowers, several insects must be controlled. These are aphids, midge, cutworms, cyclamen mites, leaf miner larvae, and leaf rollers.

Diseases which must be controlled to produce chrysanthemum cut flowers are bacterial stem rot, botyrytis mold, dodder, powdery mildew, root-knot nematodes, stem rot, stunt, and verticillium wilt.

3. Producing Cut Flowers from Carnations

The production of cut flowers from carnations offer the advantage of being able to continuously produce a crop for a period of two to three years. This eliminates preparation and replanting costs. However, older plants do not always produce the quality desired. Another consideration when flowers are produced continually is the high demand periods. The plants must be managed for maximum production during these periods and a constant supply during the rest of the year

The same type of bench arrangement is used for producing carnations as is used for chrysanthemums.

Carnations are propagated from terminal cuttings that have been taken from stock plants that have flowered once. This gives the grower an opportunity to check for trueness of type before taking the cutting. Most commercial producers secure the cuttings from propagation specialists. After the cuttings have been placed in the media (sand), 10 to 14 days are required for rooting. The media used for producing chrysanthemums may be used for producing carnations. Carnations also should be planted shallow. Shallow planting causes the plant to develop roots and grow faster.

Carnations that will be pinched only once may be planted 6 by 6 inches apart while those that will be pinched periodically may be planted 6 by 8 inches apart. The stems should be supported by wire, string, or both.

In order to produce carnations and to prevent them from getting the "splits" (a disorder in which the calyx splits), the grower must not vary the temperature more than 15° F. The following may be used as a guide in determining temperature variations in degrees F.:

	Summer	Fall	Winter	Spring
Day	70	65	60	65
Night	60-65	55	48-50	55

During the late fall and winter, carnations should be exposed to the maximum amount of light; however, in the summer it will be necessary to provide partial shade to reduce the temperature and light intensity.

Rhizoctonia stem rot, fusarium wilt, botrytis blight, and fusarium rot are the principal diseases that the greenhouse operator must control when producing carnations.

Pests that must be controlled are the two-spotted mites, thrips, and aphids.

4. Producing Cut Flowers from Snapdragons

The demand for snapdragon cut flowers has increased in the last few years. Making progress with the demand has been the development of varieties which may be produced on a year-round basis. Also, production trends have changed. Formerly, growers produced two or three flowers from the same plant. Presently, growers are producing a single stem and replanting the crop.

Snapdragons are propagated from seeds, which are packaged 2,000 seeds to the packet. A grower usually may expect 800 healthy seedlings from a packet. Seeds are sown directly into the propagating bench, flats, or containers which have been filled with a coarse media that is low in fertility. Fertilizer should be applied when the true leaves have developed. The first application is usually about one-half strength to prevent shocking the plant and retarding growth.

The ideal soil temperature for germinating snaps is 70°F. After the seeds have germinated, the seedlings should be conditioned by exposing them gradually to more sunlight and by reducing the amount of water, humidity, and temperature. The seedlings are transplanted directly into benches or small pots when the first true leaves develop or when the plant attains about one inch in height. Transplanting while the plants are small reduces shock.

Since snapdragons are basically a cool season crop, a night temperature of 50°G. id adequate, while on sunny days the ideal temperature is 60° to 65°F. The quality of the plant is depending upon lighting conditions; therefore, snaps should be exposed to full sunlight. However, partial shade may be required during hot weather.

Snaps are grown as either single stem or pinched crop; however, most growers prefer to produce single stem flowers because less production time is required. The pinched crop is spaced 7 by 8 inches and is pinched back to about three good pairs of leaves when the plant is 8 inches high.

Normally, four stems will be produced. If more stems are produced, they should be pruned.

The variety to plant is determined by whether the grower plans to produce flowers the year-round or only one crop. Also, a factor in selecting a variety is the time of year the flowers will be sold. Spring flowering varieties require about three months to produce flowers; fall flowering require as many as five months. The summer varieties flower from July to September, and winter varieties flower from December 15 to March 15. Late fall and late spring flowering varieties may also be obtained. Spring flowering varieties are McKinley, Golden Spike, Swaps, Indiana, Mayland Flamingo, and Treasure Chest.

Diseases to which snaps are susceptible are chlorosis, floret drop (shatter), floret skip, hollow stem, and wilt.

Insects that must be controlled to produce quality snaps are aphids, thrips, two-spotted mites, white flies, cyclamen mites, symphylans, and the cabbage looper.

There are not any standard grades, but the Society of American Florists recommends the following grades and standards;

Grade Designation	Minimum No. of Open Flowers	Minimum Stem Length in inches
Blue	15	36
Red	12	30
Green	9	24
Yellow	6	18

Usually snapdragons must be sold on the local market since they ship poorly. If they are shipped in a horizontal position and remain in that position for as long as two hours, the stem will bend. This reduces the attractiveness of the flower. Snaps are packed in an upright hamper-type container.

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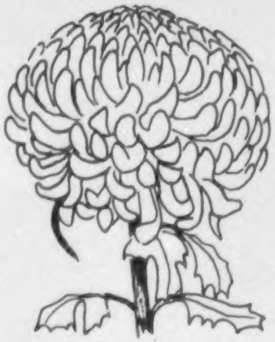
1. Laurie, Alex and others, Commercial Flower Forcing, McGraw-Hill Book Company, New York, 1969.

2. The Ball Red Book, George J. Ball, Inc., West Chicago, Illinois, 1972.

3. "Greenhouse Crop Production," Vol. 10, No. 3t, Pennsylvania State University, University Park, Pennsylvania, 1969.

TYPES OF CHRYSANTHEMUM FLOWERS



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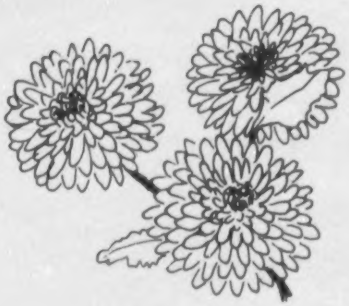

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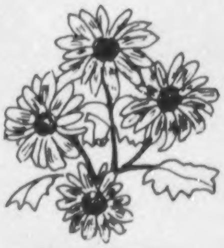

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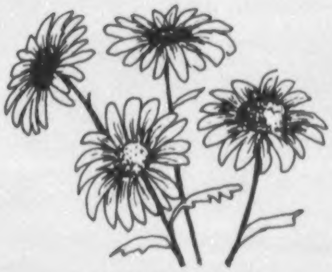

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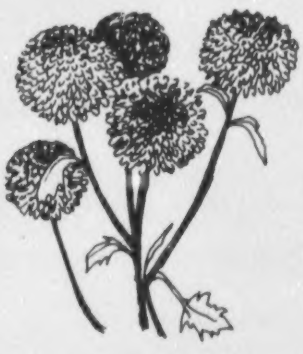

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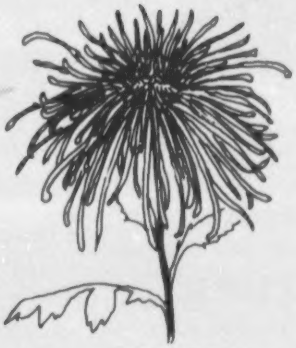
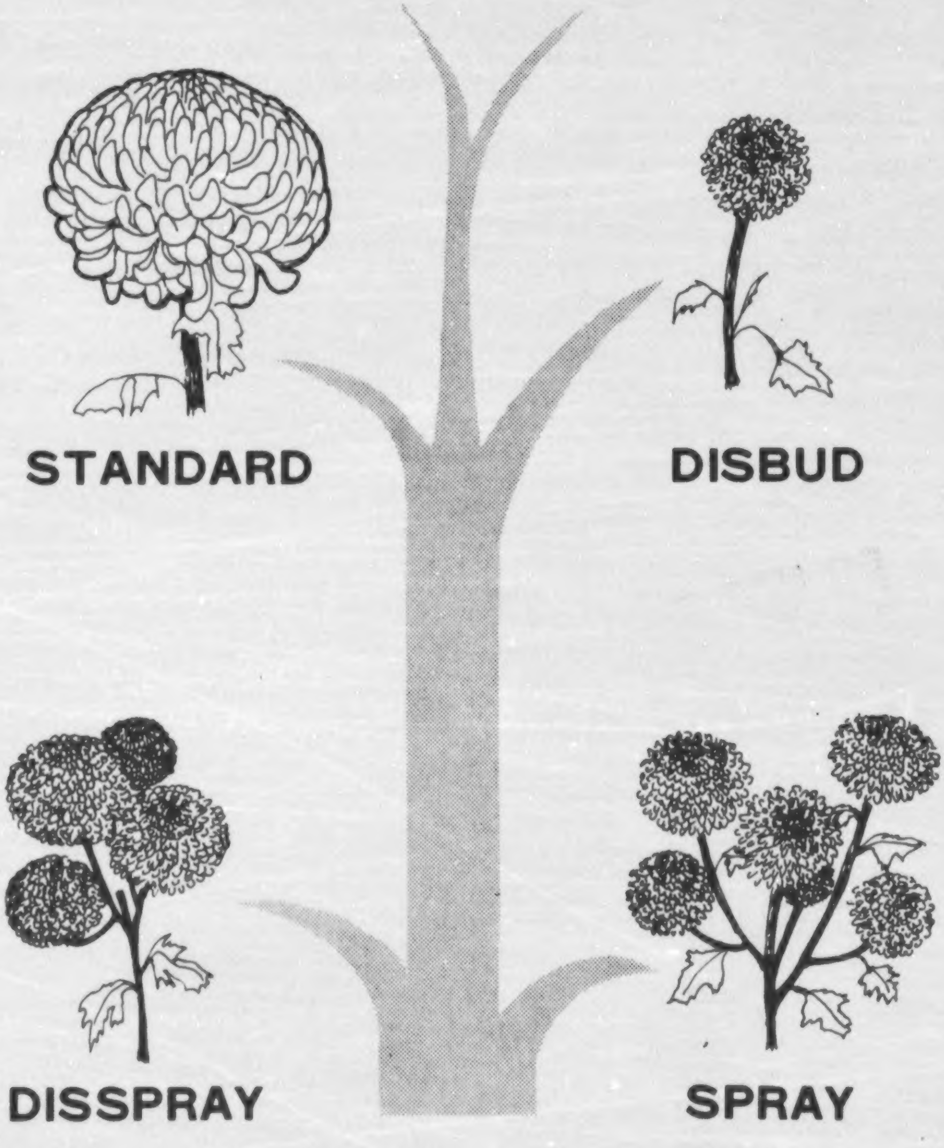


SPIDER

GROUPS OF CHRYSANTHEMUMS BY GROWTH PATTERNS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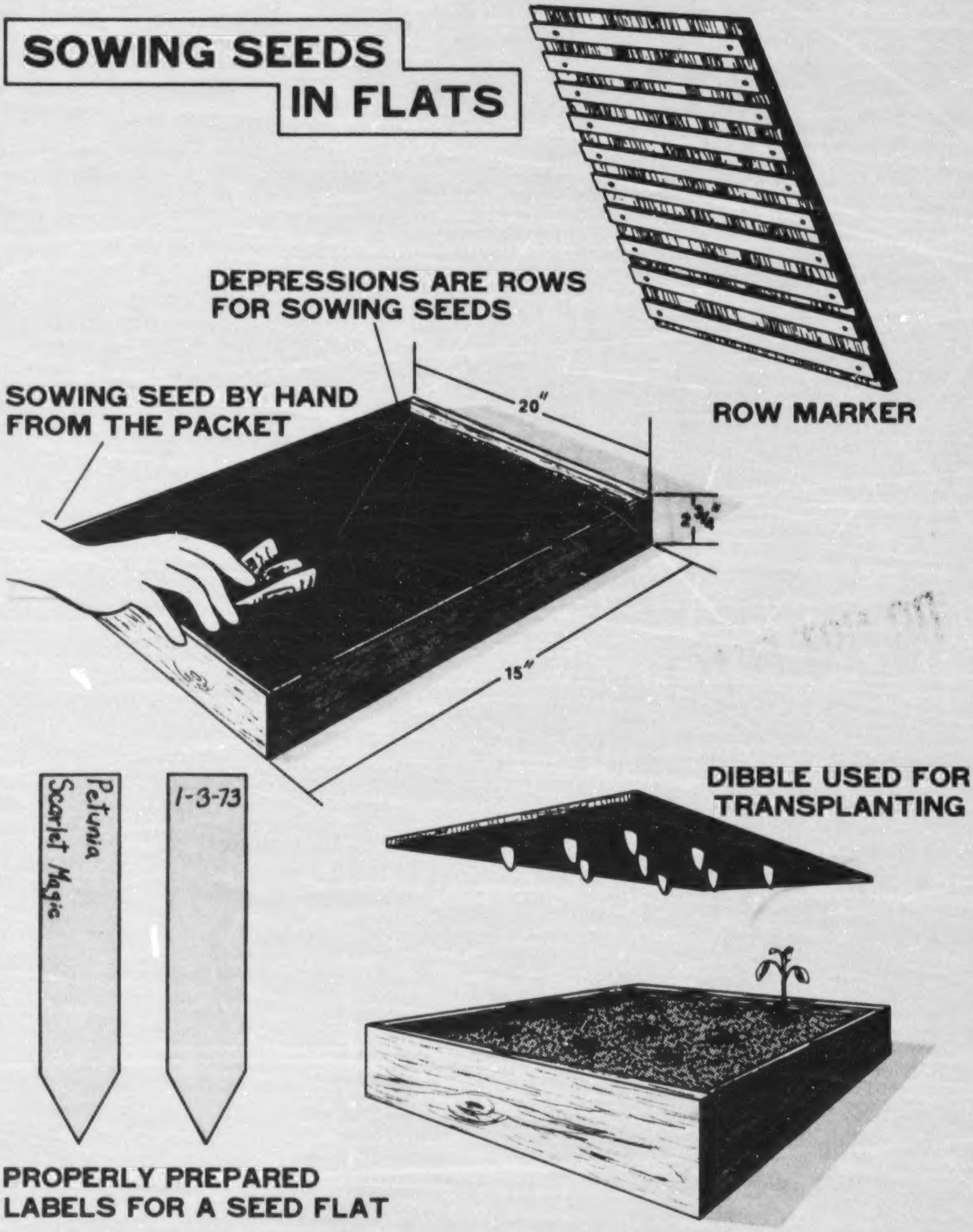
SOWING SEEDS IN FLATS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CVAE AND VEH HORTICULTURE

Unit G: Growing Greenhouse Plants

Topic 2: Pot Flower Production

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction

The demand for pot flowering plants has experienced about the same increase in demand as cut flowers, floiage plants, and bedding plants. According to the survey conducted by the Statistical Reporting Service in 22 states, growers intended to devote 42 million square feet of greenhouse space to the production of poinsettias, geraniums, and hydrangeas. While these three plants represent a large part of pot plant production, many other kinds of pot plants are produced.

The type of sales outlet affects the size of plants in greatest demand. However, usually the greatest demand is for pot plants that are compact, of high quality, and 15 inches or less in height.

2. Production of Poinsettias

The poinsettia was named after an early United States ambassador to Mexico who found the plant growing wild. He brought it to this country in 1825. It has become one of the most profitable greenhouse plants, even though it is marketed almost entirely during the Christmas period.

Prior to 1923, the poinsettia was grown as a cut flower. The introduction of the Oak Leaf variety started the production of the pot plant. Two standard varieties are the Eckespoint C-1 and the Eckespoint D-7. Some multiflowering varieties are the Annette Heeg, Mikkel Rochford, and Mikkel Scandia.

Propagation

Poinsettias are propagated from soft-wood cuttings taken from the tips of growing plants. The cuttings are usually purchased from propagators who take the cuttings from "stock plants." Most of the cuttings are sold by propagators from California.

The cuttings are taken with a sharp knife between the third and fourth mature leaves of a mature shoot. To prevent the reduction of stored food contained by the leaves, the grower should leave the leaves on the cutting. Instruments and containers used to handle the cuttings should be sterilized.

The cuttings should be pushed into the media about 2 inches and not allowed to dry out during the planting process. The media should not be compacted around the cuttings to prevent bacterial soft- root caused by insufficient oxygen.

A mist system is recommended for maintaining moisture and humidity. Moisture should be maintained on the leaves from which the cuttings are rooting.

From 14 to 21 days are required for the cuttings to root. After they have rooted, this mist should be discontinued.

Cultural Practices

Several factors such as when plants will be sold, pot size, whether single stem or multiple plant pots will be produced, and variety must be considered in determining the product the grower is going to produce. These factors also will determine the production plan.

Poinsettias require a media that has a high water-holding capacity but that is well drained and aerated. The plants should be fertilized weekly with a 20-20-20 soluble solution applied at the rate of one ounce to two gallons of water. The fertilization should begin when the plants have grown 3 to 6 inches. The condition of the plants should alter the fertilization program.

It will be necessary to sterilize the soil and media each time the plants are transferred to a larger pot. A fungicide should also be applied to control disease the first watering after transplanting.

The temperature recommended for growing poinsettias is 65° to 70°F. Flower buds will form only if the plants receive as much as twelve hours or longer of darkness each day. This will require a black-cloth shading. Plants that form buds in September are usually ready for market by December. The grower can postpone flowering by giving the plant more light.

The reaction of growth regulators is not the same for all varieties, and a variety does not always react the same. However, growth regulators have been successfully used to control the height of plants. Other methods used to regulate plant height are giving the plant full sunlight, delaying propagation, delaying pruning, restricting water, and pinching.

Insects that attach the poinsettia are aphids, root aphids, fungus gnats, mealy bugs, and spider mites.

The following diseases must be controlled: stem and root rot (Rhizoctonia Salani), black root rot (Pythium Ultimum), black root rot (Erivinia Carotovora), and bacterial canker (Corynebacterium Poinsettia).

3. The Production of Azaleas

Azalea varieties are available that will produce blooms of various patterns and shades of pink, rose, red, crimson, orchid, and white. Varieties may be purchased that will bloom from December through May. The four principal types of greenhouse azaleas are Indica, Kurume, Pericot, and Rutherfordianas.

The Indica type is thought to have been developed in India and includes both single and double varieties.

The Kurume type was developed in Kurume, Japan; and varieties in this group produce single, small flowers. Because of its hardiness, this type is best for outdoor plantings.

The Pericot type was developed in the United States and has an intermediate flower which is smaller than the Indica but larger than the Kurume.

Rutherfordianas was developed by crossing Indica and Kurume varieties. The varieties of this type maintain quality very well.

Propagation

Azaleas are propagated by cuttings. Most greenhouse operators purchase liners from a propagator who specializes in liner production. Liners are sold by grades which are expressed as 3/5, 6/8, etc. A plant having a head between three and five inches across is a 3/5. The normal growing period for a 6/8 liner is a minimum of two years. Cuttings planted in the spring will usually grade a 3/5 by the second fall.

Cultural Practices

Azaleas should be rooted in flats containing a coarse, acid soil (pH of 4.0 to 5.5). The plant is usually transplanted in pots at about 15 months. During the active growing season, the plant should be fertilized about once a week.

In order to give the plant the proper shape, the grower must pinch the plant or spray it with a growth retardant. If a flower bud is present, the plant should be pinched rather than using a retardant. Afterwards, the plant can be chemically pinched. The chemical is used at intervals of eight to ten weeks.

The plants must be protected from the spider mite, aphids, and leaf roller and leaf miner worms.

Cylindrocladium, the most serious disease, is easily controlled by using the systemic fungicide, Benlate.

4. The Propagation of Begonias

There are two types of annual begonias which produce a number of different colored flowers. These are the fibrous-rooted and the tuberous. There are two different groups of the fibrous-rooted, intermediate and dwarf. The dwarf is the most popular. A subdivision of the two groups is the bronze and green-leaved.

Improved dwarf varieties, produce from crosses, are the Linda, Vodka, Gin, and Scarletta. Intermediate varieties, also produced from crosses, are the White Comet, Matador, Othello, Pink, and Red Tausendschon.

The most popular varieties of the tuberous begonias are the Red Solfheim, Compacta, Korolina, and Tove.

Propagation

The most economical means of propagating both kinds of the annual begonia is by seeds. The seeds should be planted in flats, peat pots, or small plastic pots. The seeds can usually be covered sufficiently by spraying them with water after they have been sown on top of the media. They should germinate in about ten days. From four to six months are required for the plants to flower; therefore, seed should be planted in January for spring sales.

Cultural Practices

A good media is fertile, coarse textured, and well drained. Because of their extremely fine root system, the fibrous rooted begonias should be fed with a diluted fertilizer solution, which should begin when the seedlings emerge from the media. After the plants have attained a size large enough for handling, they should be transplanted in 2-1/4 inch pots.

Tuberous begonias require about six month to produce. The most popular are the Christmas varieties, which are difficult to propagate. Many growers purchase them in 2-1/2 inch pots from propagation specialists in June and force them for the Christmas market.

5. The Production of Geraniums

The geranium ranks sixth in sales of the potted flower crops produced; however, it is continuing to gain in popularity. Possibly, the reason for its increase popularity is its ability to grow and produce flowers in a wide range of conditions with a minimum of care and a long flowering period (all summer if proper care is given).

The present demand for flower color is 65% red, 20% pink and 15% white. Some red varieties are the Sincerity, Irene, and Cardinal. Varieties producing pink flowers are the Penny, Skylark, and Salmon Irene. Some white flowering varieties are the Snowmass and Modesty. There are many other desirable varieties producing the three flower colors not listed.

Propagation

Geraniums are rather easy to produce from cuttings. The producer can either select cuttings from his stock plants or purchase them from propagation specialists. Terminal or tip cuttings from 2-1/2 to 4 inches long and containing three perfect leaves should be selected. Cuttings will root equally as well whether taken at or between the nodes.

The plants may be propagated in a bench or in pots. Sterilized media (sand or sand perlite mixture) is recommended for bench propagation. A mixture of two parts of soil, one part of sand, and one part of peat is recommended for pot propagated plants.

The use of a rooting hormone will assist the cuttings in rooting. The recommended bottom temperature for bench propagated cuttings is 70°F.

Bench propagated cuttings should be spaced 2 by 4 inches. During the first seven to ten days, the cuttings should be kept turgid; and afterwards they should be kept reasonably dry.

Cultural Practices

Cultural practices to follow are determined to some extent by the method of propagation the greenhouse operator follows. Bench propagated plants should be transferred to a 2-1/4" pot after the cutting has produced roots and begins to grow. The transfer of the plant from the 2-1/4" to the 4" pot varies according to the speed the plant is forced. Some growers move to 4" pots in March. These plants should flower in April or May.

If the plants are properly spaced and grown, it is usually not necessary to pinch them in order to get the proper shape; however, if it is necessary to pinch the plants, the last pinch should be made in February.

The disease giving the grower the greatest problem is stem rot (blackleg) caused by a fungus organism. Geraniums are susceptible to several viruses which must be controlled.

Insects attacking geraniums are mealy bugs, whiteflies, leaf rollers, and red spiders.

Several strains of geraniums have been developed which may be propagated from seeds. Although geraniums produced from seeds represent only a small part of the total crop sold, they are increasing in popularity and seeds are widely used.

Carefree, Firecracker, and Scarlet Flash are three strains, and Nittany Lion and Sprinters are hybrid varieties. Because plants must be hand-pollinated and the geranium flower produces only 3 to 5 seeds, the seeds are expensive.

6. The Production of Gloxinias

Gloxinias may be produced in the greenhouse in any season of the year. The velvety foliage and large bell-shaped blooms, in assorted colors, make them very attractive plants.

Several different varieties and crosses are available, but varieties producing red and scarlet flowers are most popular. Varieties producing these colors are the Panzer's, Edelrot, and Ultra Scarlet.

Propagation

Gloxinias may be propagated by seeds or tubers. Producing them from seed is more economical. Seeds are sown in flats or peat pots and grown under humid conditions. Also, small potted plants may be purchased from propagators the year-round.

Cultural Practices

Four to six months are required to produce a flower from seed. A loose, open, rich, well-drained soil is recommended as a media.

There is a tendency for the plants to grow too tall. Setting the plant deeper in the pot when transplanting will reduce the length of stem and cause the plant to grow more compact.

The plants are usually transferred from the flat to a 2-1/4" pot. From these pots, they are transplanted into finishing pots.

It may be necessary for the grower to filter the light. Generally, water does not spot the leaves of plants grown under a shade. If the leaves or foliage becomes spotted, water must be prevented from getting on the leaves.

The ideal temperature for growing is 70°F.

7. The Production of Hydrangeas

The production of hydrangea pot plants offers several advantages to the grower: attractive color, long lasting flowers, and easy forcing.

Popular varieties are Rose Supreme, Merritt's Supreme, Merveille, Todi, and Strafford. Several colors of flowers may be produced from the above varieties.

Propagation

Both leaf-bud and stem cuttings are used to propagate hydrangeas; however, stem cuttings are usually used because leaf-bud cuttings require a longer growing period. Stem cuttings are taken from the tips of vegetative shoots and the lower nodes of long shoots. The cuttings are taken in May and should be rooted by June.

Cultural Practices

The plant will grow in a neutral soil, but there is a tendency for plants grown in this type of soil to develop chlorosis. Since the soil acidity affects the bloom color, growers wanting pink and white blooms should use a growing media with a pH of 6.5. The soil should have a pH of 5.0 for blue flowers.

The media for growing hydrangeas should be light, coarse, and well-drained. They have a high water requirement but are intolerant to wet soils.

The fertilizer recommendations for hydrangeas are a 2-1-1 or 3-1-1 formula. The plant is more responsive to nitrogen and requires lesser amounts of phosphorus and potash.

The photoperiod is very important in their production because it affects vegetative growth, flower formation, and forcing. Rapid growing plants exposed to the light of long days develop long stems. A shorter period of daylight slows growth and causes buds to form.

The recommended temperature for forcing the plants is 60^{o} to 70^{o}F. After the flowers form, a temperature of 55^{o} to 60^{o} F. will cause the flowers to become larger and retard stem growth. Several different commercial growth retardants have been used successfully in retarding stem growth.

The size of pot should be based on the number of blooms the grower expects to produce per pot. The following pot size recommendations are based on the number of blooms per pot: 5-1/2" pot, single bloom; 6" pot, two blooms; 6-1/2" pot, three blooms; and 7" pot, five blooms.

The insect most often attacking hydrangeas is the aphid, and the plants are susceptible to damping-off and several virus diseases.

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1. Laurie, Alex and others, Commercial Flower Forcing, McGraw-Hill Book Company, New York, 1969.

2. The Ball Red Book, George J. Ball, Inc., West Chicago, Illinois, 1972.

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CVAE AND VEH HORTICULTURE

Unit G: Growing Greenhouse Plants

Topic 3: Bedding Plant Production

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction

The term "bedding plants" refers to both flowering and vegetable plants. Most bedding plants are annuals and require from three to five months to produce flowers or fruit.

Time of planting bedding plants varies from one area of the state to another, but generally the greatest demand is in the spring. Different marketing areas require different size plants; and in some areas, the consumers prefer bedding plants that are in bloom.

Since the greatest demand for bedding plants is during the spring holidays, (Mother's day), bedding plants compete for greenhouse space with other plants sold during this period. Competition can be reduced by producing bedding plants in temporary structures. Normal weather conditions for the area will determine the type of structure that can be used.

Petunia is the bedding plant grown in the largest quantity; but many other plants, such as marigolds, pansies, geraniums, verbena, periwinkle, and vegetables may be grown and sold.

2. Producing Bedding Plants

Most bedding plants are propagated by seeds, since this is the most economical means; however, some plants, such as the geranium, are propagated by cuttings.

The bottom temperature recommended for propagating bedding plants by either method of propagation is 70°F. At this temperature, most seeds will germinate in about a week, but some seeds may require longer.

Propagation and Growing Media

Since much of the media is sold with the plants, the grower must have a reliable source of ingredients from which to make his media.

The germination media mixture to use is determined by the size of seeds to be planted. In order that very small seeds will have maximum contact with the media, they should be planted in media with very small particles. The media particles may be larger when larger seeds are to be planted. Small seeds should be covered with a thin layer of peat moss which has been run through a fine screen. The layer of peat is just thick enough to hide the color of the media. A piece of window screen mounted on a wooden frame makes a good screen. The peat is rubbed through the screen. Only a small amount of fertilizer nutrients should be added to propagating media. Calcium and superphosphate are the elements usually included.

The ingredients used to make the media mixture is a personal preference. Two mixtures used by some growers are equal parts of soil, peat, and perlite and equal parts of peat and fine perlite or fine vermiculite. Regardless of the materials used in the mixture, the media should be light, porous, and well-drained; and all ingredients used should be sterilized. Steam sterilization is the best, but chemicals may be used.

The growing media should contain more soil and fertilizer than the propagating media. It should be well-drained, easily managed, and have more nutrient- and water -holding capacity.

Sowing Seeds

The type of container that will be used and the size of seeds will determine the method of production. Small seeds are usually sown in flats, while larger seeds are usually sown in the containers in which they will be sold.

Transparency No. 1

Flats may be purchased in several sizes, and they are made of several different materials. The average size flat is 15"x20" and 2-3/4" deep. The flat is filled within about 1/2" of the top with media, and rows (shallow depression in the media) are marked with a row marker. Prior to seeding, the media is watered by gently spraying the flats.

The seeds may be sown with a vibrator seeder or by hand cut of the seed packet. When sown by hand, the grower holds the open end of the seed packet over the row and gently taps the packet, causing the seeds to fall out. The packet is moved along the row as the seeds fall. The seeds are spaced 1/8 to 1/4 inch apart and covered with a thin layer of peat. The flats should be labeled immediately after they are planted; otherwise, the grower may be unable to identify the plants.

If larger seeds are going to be sown in a flat, they should be spaced 1/4 inch apart in the rows and covered with media. If the seeds are going to be germinated in a sales container, two to three seeds are sown for each plant desired. When the seedlings are one to two inches high, the excess plants are cut off at the soil surface with scissors. Marigolds, peppers, tomatoes, and cabbage are often handled in this manner.

Watering Bedding Plants

All of the flats should be watered with a mist system or a fog nozzle after the seeds are sown. It may be necessary to cover the flats with a cloth to prevent the water from disturbing the seeds and media and to secure a uniform covering of water.

After the flats are watered, they may be covered with a polyethylene film to maintain the high humidity needed for good germination. If film is used, the flats must not be placed in the direct sunlight, as direct sunlight will develop an excessively high temperature under the film. The film should be removed after the first sign of germination. Then the flats should be exposed to maximum sunlight. This will discourage damping-off.

Fertilizing Bedding Plants

To maintain rapid growth, the grower should fertilize the plants periodically during the growing period. The most practical method of fertilization is to use a soluble fertilizer in an injector system. With this system a small application may be applied each time the plants are watered.

Transplanting Bedding Plants

After the first set of true leaves has developed, the plants should be transferred from the flats to containers. If transplanting is delayed until the second set of leaves develop, the plant root system has become so extensive that much of it will become bruised and the possibility of rotting is increased. Plant losses could be high.

A dibble is a very useful tool for making holes in the media in which to transplant the seedlings. A small trowel or label stick is used to remove the plants from the flats. The media is firmed around the roots after the seedling is transplanted.

Growing the Plants

After the plants are transplanted, the temperature should be lowered to around 60°F. To prevent the plants from becoming stemmy, the grower may wish to grow them under a limited amount of sunlight each day for about a month. A black cloth is used to cover the plants for the rest of the day.

After the plants have been grown under limited sunlight for four to five weeks, they may be sprayed with a growth regulator to maintain their compactness. Several growth regulators are available. One that has been used successfully is B-nine. Directions furnished with the regulator should be followed. Some plants respond to this treatment better than others. The treatment does not affect flowering.

Diseases and Insects

The most common disease affecting bedding plants is damping-off, which is caused by one of three pathogens: Rhizoctonia, Pythium, or Phytopthora. These pathogens usually produce seed decay, stem rot, or root rot; however, they can affect the upper portion of the plant.

The ideal environmental conditions for growing bedding plants also are ideal for the disease pathogens. The best method for controlling them is to provide an unsuited environment. This can be done by allowing as much air in the greenhouse as possible. Another method of controlling pathogens is to treat the area with chemicals. All tools and equipment should be disinfected, and care should be taken to prevent the reintroduction of pathogens from footwear containers, and equipment. LF-10 is a good disinfectant for tools and equipment, while 1/2 pound each of Dexon 35 and Terraclor 75 to 100 gallons of water used as a soil drench should be applied to the plants. Three ounces of Morsoden to 100 gallons of water also may be used to control the pathogens.

Symptoms of damping-off are rotting of stems at ground level, the toppling of plants (caused by the weakened stems), and the dying of plants in expanding circles (caused as the disease spreads).

Another disease of bedding plants, caused by Botrytis cinera, is botrytis blight. It is often called gray mold because in the advanced stages the affected part of the plant is covered with masses of gray spores. This disease attacks the upper part of the plant and moves downward.

Since Botrytis spores multiply in old stems, leaves, and flowers, their disposal will assist in controlling the disease. Another method of control is to prevent moisture from forming on the leaves and stems of the plants. Watering early in the day and providing ventilation and circulation will prevent moisture from forming on the plant.

Slugs and aphids are the two most common insects attacking bedding plants. Other insects that might attack the plants are the two-spotted mite and the white fly. Chemicals are available that will control all of these insects.

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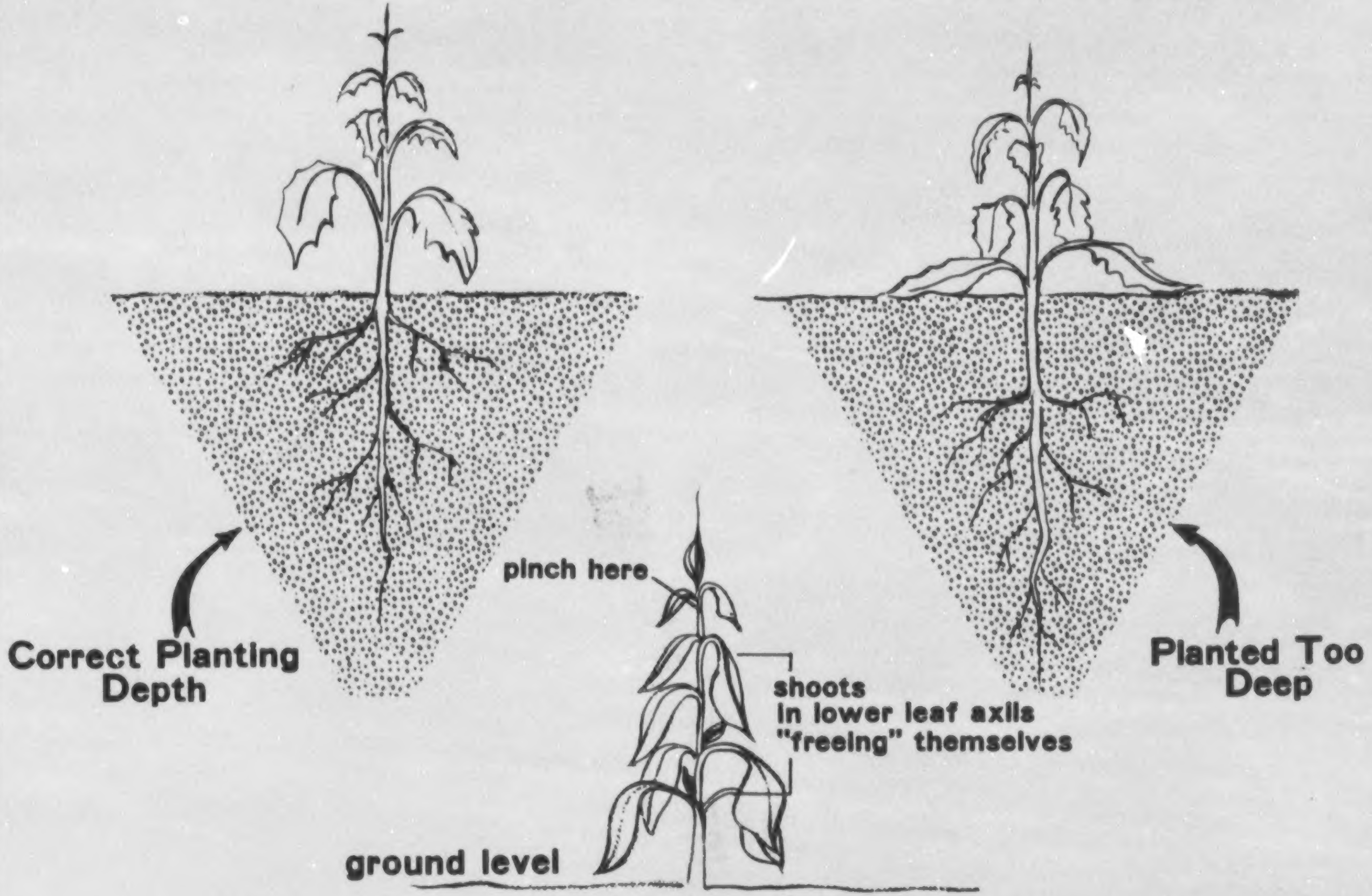
PLANTING DEPTH & STAGE FOR PINCHING


Correct Planting Depth
Planted Too Deep
pinch here
shoots in lower leaf axils "freeing" themselves
ground level

Proper Stage of Growth for the First Pinch

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Agricultural Education

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CVAE AND VEH HORTICULTURE

Unit G: Growing Greenhouse Plants

Topic 4: Outdoor Foliage Plant Production

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction to the Production of Foliage Plants Outdoors

Foliage plants are grown for the attractive, pleasing effects of their leaves and stems. One advantage of growing outdoor foliage plants is that they may be grown in areas of restricted sunlight. Usually 1,000 foot candles of light is adequate. An understanding of their origin and the environmental conditions of the area in which they are found in nature will assist the grower in propagating and growing them.

Transparency No. 1

Foliage plants are adapted to a tropical climate. Environmental conditions provided by a tropical climate are a temperature of 70°F. or above, a humidity of 75 or 80 percent, a soil with the capacity to hold large quantities of water and one high in organic matter and humus, and protection from the direct sunlight. The above environmental conditions should be provided for maximum growth. However, foliage plants can be maintained with as little as 100 foot candles of light and in a dry soil.

The soil or media used to grow foliage plants should have a pH of 4.0 to 5.0. A mixture of acid peat moss, fine soil, and a small amount of organic fertilizer makes a good media. After the plants develop a root system, nitrogen should be applied periodically in small applications.

Many foliage plants require a moist soil for proper growth; however, the grower should know the water requirements of the individual plant to determine moisture needs.

Since there is some variation in the amount of light needed by different foliage plants, the grower also must know the light requirements for the plants he is growing. Most foliage plants are grown in partial shade.

Because many of the environmental conditions required by foliage plants are found in Florida, there are many producers in that state growing and shipping foliage plants to greenhouse operators and others throughout the country. Other areas in the south and southwest also have a favorable climatic conditions for growing of foliage plants outdoors during a part of the year. Greenhouse operators who live in an area that does not have favorable growing conditions must duplicate these conditions in the greenhouse to produce foliage plants.

A large number of foliage plants can be grown under a controlled environment, such as a greenhouse, but only a limited lumber can be grown under a controlled environment, such as a greenhouse, but only a limited number can be grown out-of-doors for an extended period of time. A discussion of some foliage plants which can be grown out-of-doors is given below.

2. Growing Caladiums

The caladium is a native of the Amazon River in Brazil. It is used as a bedding and pot plant. The ideal environmental conditions for growing caladiums are a high temperature; high humidity; and a rich, moist, well-drained soil.

There are a number of caladium varieties, but the greatest demand is for varieties that have white leaves and green veins. The two types, based on the leaves of the plant, are the fancy-leaf and the lance-leaf.

Some of the fancy-leaf varieties are the Candidum, Carolyn, Whorton, Edna, Freida, Hemple, and Itacapus.

The lance-leaf varieties have heavy-textured, leathery leaves. Varieties are the Rosalee, Pathos, Pink Glow, Ace of Spades, and Elizabeth Lou.

Propagation

Caladiums are propagated from tubers grown in Florida. The principal factor in determining the size of plant that may be grown is the size of tuber planted, so tubers are sold by grade, which is determined by the diameter across the tuber. The grades are as follows: Mammoth, 3-1/2" or more; Jumbo, 2-1/2" to 3-1/2"; No. 1, 1-1/2" to 2-1/2"; No. 2, 1" to 1-1/2"; and No. 3, 3/4" to 1".

When the tubers are planted, they should be covered with about one inch of media. The bottom temperature should be 80° to 85° F. An electric heating cable may be used to maintain this temperature. If the tubers are to be placed in pots, the bottom temperature may be maintained by placing the planted pots on the sand in the propagating bench where the heating cable is located. The pots should be covered with a sheet of plastic to maintain the necessary humidity until the plants begin to grow.

Tubers will develop more eyes if they are planted with the eyes placed down. Tubers generally have one major eye and several minor ones. The major eye produces the main branch, while the smaller eyes produce the other branches. The plant can be made more bushy by removing the major eye when planting the tuber.

Cultural Practices

Caladiums to be sold as pot plants should be transplanted into the pots in which they will be sold as soon as the plants are growing well. Usually, this is two to three weeks after they are planted. A four - or - five inch pot is adequate for planting a single plant. If more plants are to be planted in a pot, a six - or seven - inch pot should be used.

The plants may be planted outdoors as soon as the minimum daily temperature does not go below 65°F. The fancy-leaf varieties develop faster if planted in a well-drained soil and area that is partially shaded.

3. Growing Codiaeums (Crotons)

This native of South America is almost limitless in range and variety of leaf colors. It is often used in combination with other plants in making attractive planter boxes and baskets.

Propagation

Two methods may be used to propagate this plant. One method is to take cuttings in February or March and provide high humidity and a bottom temperature of 75°F. Covering the cuttings with plastic will help maintain the proper humidity.

The other method of propagating is to air layer the top growth of the plant. The temperature and humidity requirements are the same for both methods.

Cultural Practices

A mixture of compost and sand is recommended for growing crotons.

4. Growing Coleus

The coleus is a member of the mint family and was first grown in the monastery gardens of Europe. They are grown almost everywhere now. Coleus bleumi is a perennial and a native of Java.

There are three classes of coleus based upon the size of their leaves. These are the small-leaved, intermediate, and large-leaved. Small-leaved varieties are the most popular. Intermediate varieties are bushy and free-branching.

Some of the varieties developed at Texas A&M University are the Aggieland, Anna Pfitzer, Autumn, Texas A&M, and Texas Sunset. The color preference is for plants that have shades of red in the leaves.

Propagation

Coleus may be propagated from seeds, but most of the plants are propagated from stem cuttings taken from the tip of plants. Cuttings are selected that contain three sets or pairs of leaves below the tip. The bottom pair of leaves are removed, and a cut is made just below the bottom node. The cutting then is stuck in the propagating media up to a point just below the second pair of leaves, and the soil is firmed around the stem. A one cubic yard media mixture recommended for propagating coleus is as follows:

13.5 cu. ft. horticultural grade perlite
13.5 cu. ft. sphagnum peat moss
5 lbs. superphosphate (20%)
10 lbs. dolomite
5 lbs. complete fertilizer (8-12-4)
3 ozs. chelated iron

The ingredients should be thoroughly mixed.

Some growers may prefer to propagate coleus in pots. Three cuttings are usually placed in a six-inch azalea pot, and the pot is placed in a plastic bag. The bag is tied or stapled at the top. After about seven days the top of the bag is opened. The bag is removed five to seven days after is opened.

Coleus cuttings also may be rooted in water. Approximately ten days are required for the cuttings to root.

Cultural Practices

About two to three months, depending upon the method of propagation, are required to grow coleus to a marketable plant. Cuttings require slightly less time than plants propagated from seeds.

During the first six to eight weeks of the growing period, the plants should be fertilized with a 20-20-20 analysis soluble fertilizer when they are watered. The solution should contain 12 ounces of fertilizer to 100 gallons of water. The fertilizer application should be discontinued about three weeks before the plants are to be sold.

To make the plant bushy, the grower should pinch the cutting about seven days after it has been made and about every two weeks afterward for about six weeks.

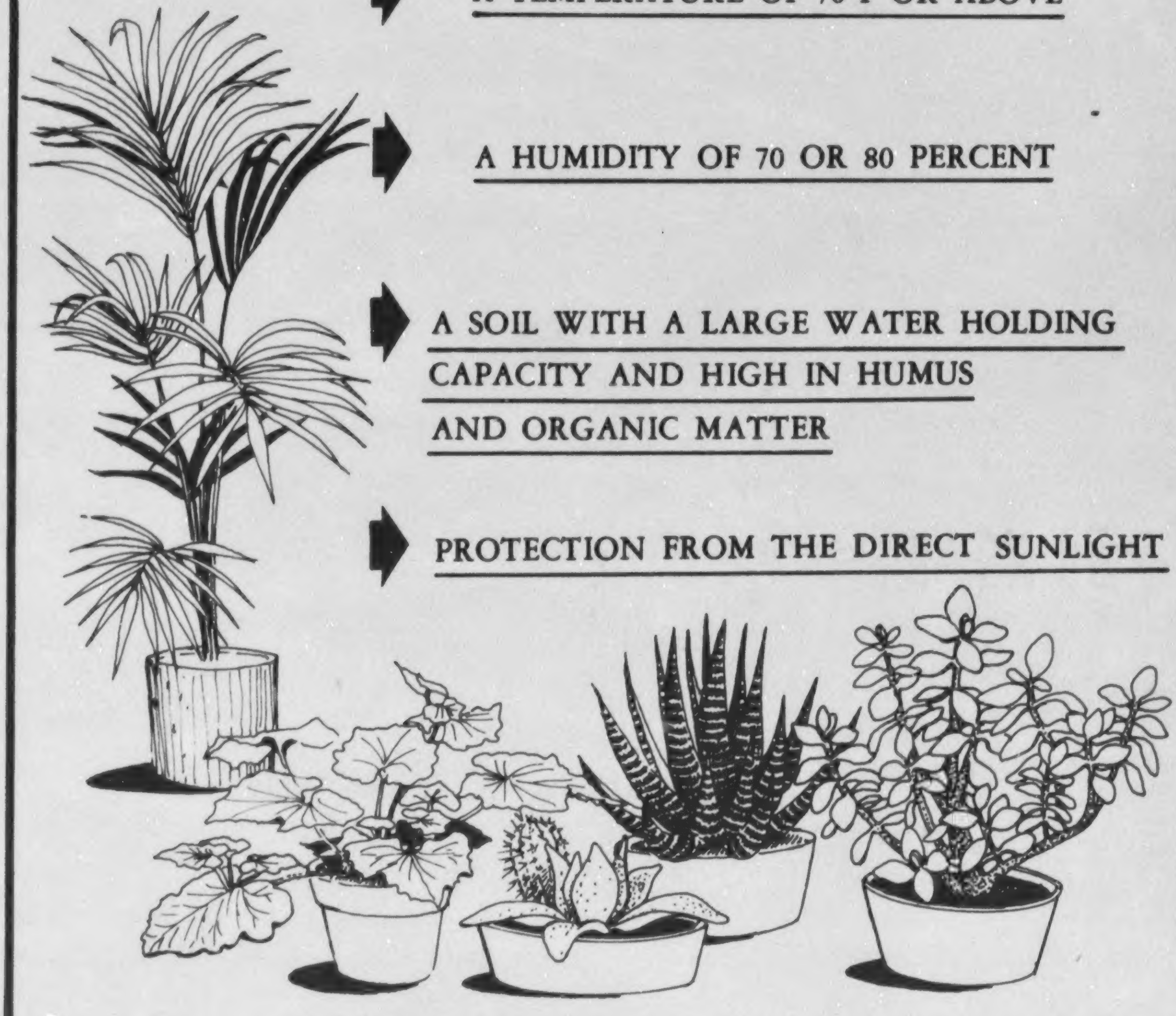
REFERENCES:

1. The Ball Red Book, George J. Ball, Inc., West Chicago, Illinois, 1972.

2. Graf, Alfred B., Exotic Plant Manual, Roehrs Company, East Rutherford, New Jersey, 1970.

3. "Selecting and Growing House Plants," United States Department of Agriculture, B82.

FAVORABLE ENVIRONMENTAL CONDITIONS OF FOLIAGE PLANTS



- A TEMPERATURE OF 70°F OR ABOVE
- A HUMIDITY OF 70 OR 80 PERCENT
- A SOIL WITH A LARGE WATER HOLDING CAPACITY AND HIGH IN HUMUS AND ORGANIC MATTER
- PROTECTION FROM THE DIRECT SUNLIGHT

Vocational Instructional Services
Agricultural Education

G-5
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CVAE AND VEH HORTICULTURE

Unit G: Growing Greenhouse Plants

Topic 5: Indoor Foliage Plant Production

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Due to space limitations only a few plants are discussed. The teacher may wish to include other foliage plants in the presentation of the topic to the class.

Allowing the students to observe the growing plant while its method of propagation and cultural methods are discussed expedites learning.

1. Producing Foliage Plants for Indoor Use

Most of the foliage plants grown for indoor use are classified or called exotic plants. They are natives of a tropical climate, which has soils high in organic matter, which has soils high in organic matter, a minimum temperature of about 70°F., and high humidity and rainfall. Growing in the native environment, foliage plants were normally shaded by other growing plants.

Indoor foliage plants can be divided into two groups, (1) house plants and (2) greenhouse plants. House plants can be grown or maintained in the environment provided by a house, office, or public building. Greenhouse plants require a warmer or cooler environment and more or less humidity than can be maintained in an area other than a greenhouse. Generally, foliage plants require less water and light because they do not have to support and maintain a bloom or flower for a long period of time.

Specific environmental requirements of indoor foliage plants are discussed below.

Soil

The soil is a particularly important consideration in the production of foliage plants. The media should be high in humus, loose, well-aerated, well-drained, and sterile. A knowledge of the plant's root system will determine to some extent the media mixture to use. Foliage plants having delicate, fine fibrous roots require a media high in humus. Plants having coarse roots will grow well in coarse texture soils.

A media mixture used for growing some foliage plants is 50 percent sphagnum peat and 50 percent horticultural grade perlite. Another mixture is equal parts of sand, soil, and peat. The plant to be grown will determine the mixture. A pH range of 4.0 to 5.0 is recommended for most foliage plants.

Light Requirement

Foliage plants grow best under a light intensity of from 1,000 to 3,000 foot-candles. This about one-third of the normal light intensity on a warm, sunny day. Some foliage plants, such as evergreens and ferns require even less light (50 to 500 foot-candles). Since the light intensity requirements vary among the different plants, the grower should be familiar with the requirements of each plant.

Temperature

The minimum temperature requirement is 65°F. A higher temperature is needed to get maximum growth.

Water

Foliage plants grow best in a moist media and a high atmospheric humidity; however, they should be hardened by allowing the soil to dry out before selling to the consumer. General recommendations cannot be applied to all foliage plants, as some plants should be grown on the dry side.

Soft water is the best for watering plants since it does not contain salts. If possible, chlorinated water should not be used because it tends to check the growth of plants. Chlorinated water may be dechlorinated by allowing it to stand in an open container for 24 to 48 hours. Some growers use warm water when watering foliage plants. The warm water warms the media and raises the temperature around the plant for a period of time.

It is difficult to establish and maintain a watering schedule, since a number of factors can influence the time that plants need to be watered. The best method to determine when to water is to feel the soil. When the soil feels dry and appears to be lighter in color, it is usually time to water.

Fertilizer

Two methods of fertilizing plants are generally used by growers. One is to mix fertilizer with the media when preparing the media mixture, and the other method is to apply fertilizer after the plant is growing. If the fertilizer is going to be added to the media, the general recommendation is to add three to five pounds of dolomite and an equal amount of a complete fertilizer (6-6-6) to each cubic foot of media. The easiest way to apply fertilizer after the plants begin to grow is through the watering system.

After the plants begin to grow, it is not unusual for the soil to become deficient in nitrogen, which is indicated by pale new leaves. If this occurs, a soluble fertilizer should be applied at the rate of one pound to 100 gallons of water on a monthly basis.

There is a tendency to have a phosphate build-up in the soil after the plants have been fertilized a few times. This possibility can be eliminated by leaching the soil before each fertilization.

Insect and Disease Control

Insects and diseases must be controlled if the plants are going to grow and develop properly. Applying preventive measures is generally much easier and more economical than having to establish control measures.

The two most prevalent diseases of foliage plants are pythium root rot and rhizoctonia. These can be treated with chemicals.

2. Aglaonema (Chinese Evergreen) Production

Because of its very low light tolerance (50 to 500 foot-candles), the Chinese evergreen is particularly adapted to the indoors.

The plant has leaves growing at the end of conelike stems. The color and size of leaves depend upon the variety.

Some varieties are the Simplex, Silver King, Silver Queen, Commutatum, and Roebeline.

Plants may be propagated by either stem or tip cuttings. Cuttings and small plants also may be purchased from specialists. The price is based on the number of leaves on the plant and height of plant.

The media for growing Chinese evergreens should be high in humus and kept moist. Plants should be grown in a high temperature, low humidity, and in the shade.

3. Aphelandra (Zebra Plant) Production

This is a small, very attractive plant that can withstand low light intensity. It produces large, elliptic leaves which are green and shiny and have prominent white veins and midribs.

The plants are propagated by stem cuttings. A rooting hormone should be used to initiate rooting.

The plants should be grown in media with a high humus content, warm temperature, low humidity, and indirect sunlight.

4. Bromeliad Production

The bromeliads (Bromelia, Aechmea, Cryptanthus, Neoregelia, and Uriesia) are the most adaptable to different areas of all the foliage plants. They will grow equally as well in well-lighted areas and areas of low light intensity.

The Aechmea have gray-green, leathery leaves with silver bands, and the leaves form a rosette. The Cryptanthus form a flat rosette, and some varieties of these are very colorful. The Neoregelia are often referred to as the fingernail plant because of the red tips on olive-green leaves. The Uriesia are called the flaming sword because of their flaming inflorescence.

They are easily propagated from seeds and usually have a high germination percentage. However, a warm temperature and high humidity are required for good germination. After the seeds have germinated, only the healthy seedlings should be retained and grown.

The plants should be grown in a media high in humus content, warm temperature, and medium amount of humidity. Bromeliads are grown in a dry media.

5. Dieffenbachia Production

This is one of the most popular indoor foliage plants. The color of the leaves varies with the different varieties. The Amoena variety has large, deep-green leaves with cream-colored bands and blotches, while the leaves of the Bausei variety are large, pointed, and yellowish-green with white spots and dark green edges. The leaves of the Hoffmannii are dark green with white spots and a marbled petiole. The Picta has ivory and yellow leaves with white marbling and a dark green petiole.

The plants are propagated by either cuttings or propagating canes. The dieffenbachia may be purchased as started plants from propagation specialists.

The plant is adapted to a warm temperature and, depending upon the variety, may be grown in full or partial shade. The plant grows best when exposed to bright light.

To prevent the roots from rotting, the media should be kept on the dry side.

The lower leaves will eventually turn yellow. When this happens, these leaves should be removed. If the stem becomes bare and unattractive, the top of the plant should be removed and rooted in sand or water.

The sap of dieffenbachias is toxic to an open cut; therefore, care should be taken when leaves and cuttings are removed from plants.

6. Dracaena Production

This large family of foliage plants is particularly adapted for indoor use because they retain their foliage for a long period. The most common variety is the Godseffiana, which has dark green leaves spotted with pale yellow. The leaves are long, narrow, thick, leathery, and grown in a whorl. The plant grows upright.

Another variety is the Fragrans; it has broad, strap-shaped leaves that have a gold band down the middle. The Sanderiana variety has small, gray-green leaves bordered with a white band. A good potting soil is essential for growing all varieties.

Most varieties are propagated from root cuttings; however, some are propagated from old canes that form roots from the leaf axil.

Plants are grown in a loamy, moist soil, a warm temperature, and partial shade. The leaves should be washed monthly with soapy water. When the bare stem below the foliage gets too long, the top of the plant should be air layered.

7. Ficus (Rubber Plant) Production

In its native environment of Malaya or India, the rubber plant will attain a height of 100 feet and is a close relative of the plant that furnishes the rubber for the world.

Several different varieties are available, but the Decora is the most popular. It has heavy, dark green leaves, and a broad head. For those who like a variegated leaf, the Doescheri variety is available. The leaves are either gray, creamy white, or yellow.

Most rubber plants are propagated by air layering; however, they can be propagated by tip cuttings, a more expensive method. Specialists propagate most of the rubber plants available. The price of the plant is determined by the number of leaves.

The plant should be grown in a moist media. If the media is allowed to become too dry, the plant will drop some of its leaves. The plant is adapted to a warm temperature, medium humidity, and diffused sun. Plants growing in large pots lose their leaves if they are chilled or are moved to another location. Should a stem become bare of leaves, it should be air layered.

Growing plants should have their leaves wiped with a moist cloth periodically.

8. Nephtytis (Syngonium) Production

This ideal house plant has heart-shaped leaves with silver-white or green centers. They are particularly hardy and are one of the most attractive pot plants before they become old and begin to climb. After they begin to climb, they are used as totem poles.

The plants are usually propagated by stem cuttings and may be purchased as rooted cuttings or potted plants from propagators. The vines also may be used to produce cuttings.

The plants should be grown in indirect sunlight, warm temperature, and low humidity. The media should be kept moist.

9. Pilea (Aluminum Plant) Production

The common name is descriptive of its leaves, which are thin, fleshy, and quilted with silver markings.

The Cadierei and Cadierei Minima are the most popular varieties. The aluminum plant is comparatively easy to grow and care for.

The plant is propagated from cuttings and is available from propagation specialists.

The plants should be grown in a warm temperature and a partially shaded area. The soil should be kept moist. To prevent the plant from becoming leggy, the grower must pinch the growing tip regularly.

10. Rex Begonia Production

The rex begonia can be grown the entire year and has excellent market acceptability. It has an intricate and very colorful leaf pattern and has become very popular over a short period of time.

One disadvantage of growing this plant is the unsightly rhizomatous growth which extends beyond the edge of the pot. It loses it lower leaves in this process.

There are several varieties available, the smaller-leaf varieties are the easiest to grow and produce.

A soil high in humus, porous, and aerated is necessary to get the proper growth. The soil should be kept moist.

Most greenhouse operators purchase started plants in 2-1/2" pots, but they can be propagated from leaf cuttings. The leaf is cut into small pieces about the size of a postage stamp and placed in the media with the underside of the leaf placed next to the media. The media should be moist but not wet. Media that is too wet will cause the cutting to rot. To determine if the media contains the proper amount of moisture, the grower should compress the media with his hand and be able to squeeze moisture from it.

Compost or peat is recommended as the propagating media, and the proper propagating temperature is 65° F. About six weeks are required for the cuttings to root.

Plants purchased in 2-1/2" pots are normally transferred to 4" azalea pots and grown at 60° F. The proper light intensity for maximum growth is 2,000 foot-candles. This amount of light should give the leaves excellent color.

The plants should be fertilized regularly during the growing period with a soluble fertilizer. A 15-30-15 analysis fertilizer applied at the rate of one ounce to four gallons of water is recommended. Also, a 12% iron chelate solution supplied at the rate of one ounce to twenty-five gallons of water should be applied twice at equal intervals during the growing period. A six to eight weeks growing period is usually required to prepare the plants for market.

11. Sanseveria (Snake Plant) Production

Since the snake plant will grow and thrive under adverse conditions, it makes an ideal plant for indoors. The two most important factors in growing the plant are the water and temperature, because the plant will die if overwatered or chilled.

The several species and varieties available may be classified into three groups: Zeylonica, Laurentii, and Hohni. The Zeylonica has leaves with crossbands that are light green to grayish-white, while the Laurentii has yellow crossbands. Being smaller than the other two, the Hohni grows in a rosette and does not have the long, sword-like leaf.

The Zeylonica is propagated from leaf cuttings. The leaf is cut into two - to three - inch lengths. The Laurentii must be propagated by division. When it is propagated by cuttings, the leaves are green instead of striped.

The plants are grown in a warm atmosphere and low humidity. The light intensity may be from dim to full daylight.

12. Schefflera (Umbrella Tree) Production

The umbrella tree is a fast-growing plant with large compound leaves that have six to nine leaflets. The leaves are slender, fleshy, and glossy green.

Plants are propagated from seeds. Seedlings and potted plants are available from specialists.

A regular potting soil is used to grow plants. The soil should be allowed to become dry between waterings. The plants should be grown in indirect sunlight, warm temperature, and low to medium humidity.

REFERENCES:

1. The Ball Red Book, George J. Ball, Inc., West Chicago, Illinois, 1972.

2. Graf, Alfred B., Exotic Plant Manual, Roehrs Company, East Rutherford, New Jersey, 1970

3. "Selecting and Growing House Plants," United States Department of Agriculture, B82.

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CVAE AND VEH HORTICULTURE

Unit G: Growing Greenhouse Plants

Topic 6: Growing Plants for Totem Poles

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

After covering the topic in class, the students should be given the opportunity to prepare totem poles.

1. Totem Poles

As the demand for indoor plants has increased, florists, greenhouse operators, and others in the business of selling ornamental plants have attempted to design unusual floral and foliage plant arrangements in an effort to further increase demand and sales. The totem pole has been one foliage plant arrangement that has been used in this effort.

Transparency No. 1

The plant selected for a totem pole must be one that will run or climb after it has grown for a period of time. Several different kinds of materials may be used to make the poles. A stick or hardware cloth (woven wire) wrapped with two to three inches of sphagnum moss tied to the pole or cloth may be used. Commercial poles made from pressed tree fern also are available from most suppliers of greenhouse supplies and equipment.

The length of the pole is determined by the size of pot or container in which the plant is growing. The container should be large enough to hold enough media to maintain the pole in an upright position.

After the plant has begun to run and the pole has been placed in the container, the wire is wound around the pole and fastened to the pole with wire ties. If the pole is kept damp, the roots of the plant will grow into the pole, and the plant will form more leaves.

Several different kinds of vines and trailing plants may be used for making totem poles. However, philodendrons and scindapsus are the most popular and the two discussed in this topic.

2. Philodendron Production

This is one of the most popular tropical plants being grown today. Its tolerance of dry air and low light intensity and strong climbing ability make it ideal as a house plant, as well as for making totem poles.

There are over one hundred different kinds, with the most important variety being the Cordatum. Cordatums are grown on 24-inch, 36-inch, and 48-in poles. The large leaf philodendrons are grown on poles from 24 inches to 72 inches; however, the 36-and 48-inch are the most popular. Some other varieties are the Hastatum, Pandeuraeforme, and Pertusum. Some hybrid varieties are Emerald Queen, Red Emerald, and Florida. The Pertusum is the most widely used for totem poles, while the Cordatum has the most decorative foliage.

Propagation - Several kinds of cuttings are used to propagate the plant. The kind used is determined by the variety being propagated.

Cultural Practices - The plants should be grown in a moist potting media, indirect sunlight, warm temperature, and low humidity. The leaves should be washed monthly with soap and water, but the soapy water should not be allowed to get into the media. The application of special foliage waxes is not necessary when the leaves are washed with soap and water.

When the plant grows to the end of the pole, the stems should be cut back to force new branches to develop. Light intensity should be increased and the amount of water decreased when the plant reaches this stage of development.

3. Scindapsus Aureus (Devil's Ivy) Production

Devil's Ivy and Scindapsus pictus (Painted Devil's Ivy) are ideal plants for totem poles. After these plants are established and growing, they require a minimum of care. However, it is essential to keep the pole moist so that the plant roots will grow into the pole.

Propagation - The plants are propagated by cuttings which are placed in moist media or water.

Cultural Practices - The plants should be grown in a media high in humus content and in indirect sunlight, warm temperature (70° F. or above), and low humidity.

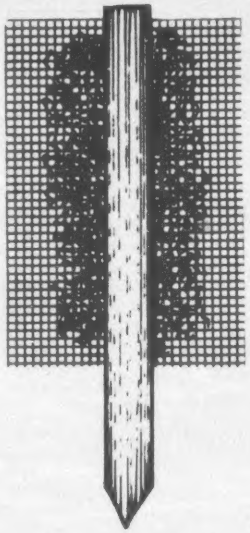
REFERENCES:

1. Graf, Alfred B., Exotic Plant Manual, Roehrs Company, East Rutherford, New Jersey, 1970.

2. "Selecting and Growing House Plants," United States Department of Agriculture, B82.

TOTEM POLE

WOOD POLE

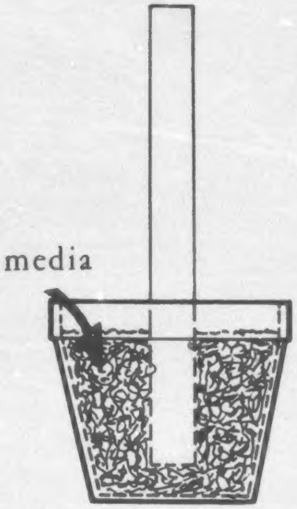


Wrap hardware cloth with sphagnum moss and tie with wire ties

PRESSED TREE FERN

CEDAR POLE

Length of pole is determined by size of container



Container should be large enough to maintain pole

MATERIALS THAT MAY BE USED TO MAKE POLE

CVAE AND VEH HORTICULTURE

Unit G: Growing Greenhouse Plants

Topic 7: Growing Plants for Terrariums and Bottle Gardens and Preparing Them

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Students should be allowed to prepare terrariums and bottle gardens.

1. Growing Plants in Terrariums and Bottle Gardens

Terrariums are often referred to as Wardian cases. The name is derived from Nathaniel Ward, who in 1929 placed a moth in a closed glass to study the emergence of the adult moth. Dr. Ward became interested in a fern and grass plant that appeared and thrived in the jar for a long period of time without any additional water or care being given to the plants. Terrariums can be made from any type of clear glass or plastic container.

The terrarium enables the grower to overcome the principal problem of growing plants indoors, dry air. It also permits the growing of a number of plants. Growing plants in a terrarium almost entirely eliminates the chore of watering. Determining when to water is another problem in the growing of indoor plants.

Since terrariums provide almost 100 percent humidity, the selection of plants is of utmost importance. All of the plants selected should require the same environmental conditions. Also, the location of the terrarium should be considered when selecting plants. By ventilating the container, a wider selection of plants may be made. Selecting a container that will allow some ventilation will also cause the temperature in the terrarium to change much slower. A gradual change of temperature is beneficial to the plants.

Wide assortments of containers may be used in constructing the terrarium. Candy jars, glass aquariums, glass teapots, fish bowls, gallon glass jars, and manufactured terrarium containers may be used.

2. Preparing the Terrarium

A thin layer of coarse materials should be placed in the bottom of the terrarium to allow drainage of excess moisture. Small aggregate or charcoal may be used and should be placed in the container first. A light textured, coarse soil is recommended as a media, but a mixture of 50% horticultural grade perlite and 50% coarse sphagnum moss may be used as a substitute. To prevent rapid growing plants from outgrowing the container in a short period time, the media should contain only a small amount of nutrients. One recommended media mixture is as follows:

1 quart of horticultural grade perlite
1 quart of coarse sphagnum moss
1/4 cup charcoal chips
1/4 teaspoon 5-10-5 fertilizer

After the media is thoroughly mixed, it is ready for placement in the container. Hills and valleys or an irregular terrain should be made when placing the media in the container.

Four types of terrariums and kinds of plants that may be grown in each are given below:

Temperate Climate Terrarium

Plants grown in this type will tolerate very little direct sunlight and need a cool temperature. Good artificial lighting should be available. Plants that may be grown in this type of environment are as follows:

Acorus gramineus
Bexus microphylla japonica
Coprosma baveri
Pittosporum tobira
Euonymus japonicus Goldspot
Podocarpus macrophyllus
Ficus pumila
Saxifraga sarmentosa
Hedera helix Shamrock

Tropical Climate Terrarium

The plants listed below require a warm temperature and good artifical light. Very little direct sunlight is needed.

Aglaonema simplex
Begonia rex
Calathea makoyana
Codiaeum variegatum
Cryptanthus zonatus
Dracaena sanderiana
Fittonia verschaffelti Pearce
Pilea nummulariaefolia
Saintpaulia varieties
Selaginella denticulata
Fern species
Scindapsus aureus
Palm seedlings
Syngonium podophyllum
Fatshedera lizei

Desert Terrarium

Plants grown in this type require a warm room and intense light. Plants should be selected from the numerous varieties of cacti and succulents.

Woodland Terrarium

Plants for this type are adapted to low light intensities and no direct sunlight. Some of the plants are as follows:

Small Adiantum ferns
Table ferns
Seedling pines
Hollies
Junipers
Selaginellas
Mosses
Lichens

Preparing Containers for Planting

The terrarium should be thoroughly washed to make it as attractive as possible. If it has been used previously, it might be necessary to soak it in a solution of Calgon for a period of time.

This arrangement of plants is left to the imagination of the person preparing the terrarium. Small objects such as rock and miniature figurines are often used to improve the decorative effects. After the placement of the coarse materials in the terrarium, the soil mix is ready to be tumbled into place. One to two inches of soil is usually adequate for most terrariums. After the proper contour of the soil has been accomplished, the plants are ready to be placed.

The larger plants are planted first by placing them in the soil and gently packing dirt around them. The smaller upright plants are planted next, and the creeping plants are planted last.

3. Preparing Bottle Gardens

The only differences between a bottle garden and a terrarium are that the plants are planted in a bottle and there are more limitations as to size and kind of plants that may be planted.

Flowering plants should not be used in a bottle garden, because when they die, the plants become vulnerable to fungus diseases. Only foliage plants should be used. The maximum size plant that may be used is one growing in a pot no larger than three inches in diameter. Plants growing in larger pots are usually too large and too tall. Five or six plants can often be grown in one bottle.

To get an idea of how the bottle garden will look, a person should make a trial run outside the bottle. This eliminates the maneuvering of plants inside the bottle.

Drainage materials and soil are placed inside the bottle by using a funnel. If an uneven surface is desired in the bottle, the bottle is tilted while the soil is poured through the funnel. The funnel can be constructed from paper if a manufactured one is not available.

Transparency No. 1

In addition to the funnel, other tools needed to place and plant the plants inside the bottle are a brass tube, tongs, and spatula. The tube is used to remove a core of soil and to make a hole for the plants. The tongs are used for placing the plants, and the spatula is used for settling the soil.

When planting in the bottle, a hole should be dug large enough in the media to receive the entire root systems of the plant. The plant roots are washed free of soil and lowered into place. Then the roots are covered and the soil firmed around them. Care should be taken not to drop soil or debris on the leaves of plants. If this is unavoidable, a small brush tied to a stick can be used to brush it off. After the arrangement has been completed, the soil and plants may be watered with a light mist. The soil should not be watered so much as to become wet.

Very little care is required after the plants are planted and watered; however, the bottle should be examined periodically. If the soil becomes too dry, a light mist should be applied. Decayed leaves should be removed. If it becomes necessary to restrict the growth of certain plants to prevent them from outgrowing other plants, the tips of these plants should be pinched. If excess condensation appears on the glass, the bottle should be given more ventilation.

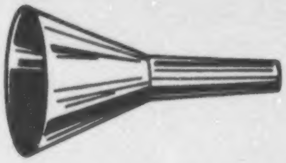
REFERENCES:

1. Graf, Alfred B., Exotic Plant Manual, Roehrs Company, East Rutherford, New New Jersey, 1970.

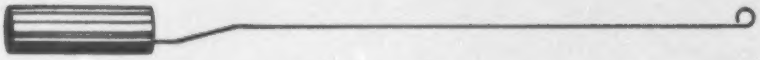
2. "Selecting and Growing House Plants," United States Department of Agriculture, B82.

3. Bailey, Leo L., A Step - By - Step Guide to Landscaping and Gardening, Exposition Press, Hicksville, New York, 1974.

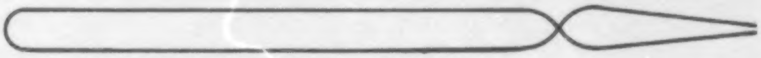
TOOLS USED IN MAKING BOTTLE GARDENS



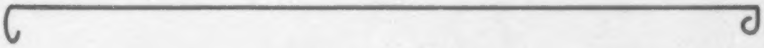
funnel



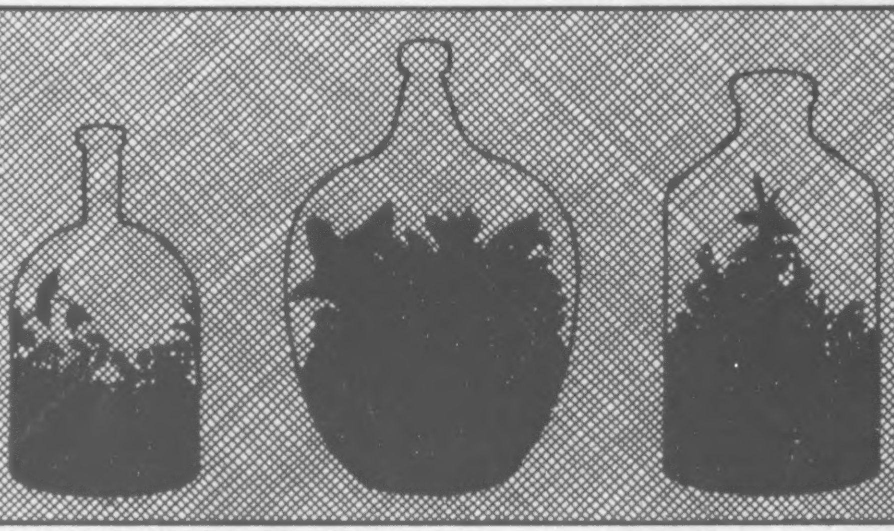
brass tube



tongs



spatula



Vocational Instructional Services
Agricultural Education

G-8
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CVAE AND VEH HORTICULTURE

Unit G: Growing Greenhouse Plants

Topic 8: Growing Succulents

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

The many families and varieties of cacti and other succulents are shown in the Exotic Plant Manual by Graf.

Students should be given the opportunity of propagating cacti and other succulents.

1. Introduction

Succulents are plants that have thick, plump, juicy leaves or stems. Although they may be found growing under a wide range of environmental conditions, most succulents are native to the arid or semi-arid regions of the Americas. However, they are also found growing in rain forests. The arid and semi-arid regions have a very high daytime temperature and intense heat, while the nights are cool or even chilly. To grow and survive under these conditions, succulents have insulating scales, hairs, wax, varnish, resin, or woody bark on their surfaces. These reduce evaporation and protect them from the extreme heat.

Because of their many different forms, beautiful colors, and unusual growth habits, succulents are prized as house and garden plants. They also can be maintained with a minimum of care, readily adapt to a wide variation of environmental conditions, and will even survive if negelected for a long period of time.

2. Cacti Propagation and Cultural Practices

There are about 2,000 species of cactus, the most popular succulent. They may be found growing from Canada to Chile in South America. However, the greatest number of varieties are found in the dry, sunny climate of Mexico. Cacti range in size from those the size of a small pebble to the "Giant Saguaro," which is 35 feet high and estimated to be 250 years old.

Propagation

Cacti may be propagated by grafting, cuttings, and seed. The specie and variety will determine the propagation method to use.

Grafting is the least often used method of propagation. It is normally used to replace a diseased root stock with a healthy one. When grafting is practiced, the vascular tissue of the graft and stock must match and be held in place until the union is completed. String or rubber bands may be used to hold the graft in place.

Cuttings are made by cutting a piece of the stem or leaf with a sharp knife. The wounded area of the cutting is dipped in powdered charcoal and allowed to dry for several days. Then the cuttings are placed in dry sand to root. Precaution should be taken not to place the cutting too deep in the sand.

Most cacti seed are viable, but they may require from one day to one year to germinate. A media consisting of equal parts of leafmold, loam, and sand is recommended for germinating seed. Seed are sown on the media surface and lightly covered with a limestone grit. The grit keeps the media surface open and reflects the sun. This keeps the sun from burning the shallow roots. A bottom temperature of 80 to 90 degrees F. is recommended. The media is kept moist by placing a pan of water under the container (capillary action). Seedlings are transplanted as soon as they touch.

Cultural Practices

The growing season for most cacti is from early spring until midsummer. During this period, the cacti should receive adequate water and fertilizer. Phosphorus and potassium are required in the greatest quantities.

The growing media should be relatively high in nutrients and rich in organic matter. The media mixture will depend upon the variety being grown. A general purpose media mixture is composed of equal parts of coarse sand, loam, and peat or leafmold. It may be necessary to add lime to the mixture, because most cacti prefer a soil pH of 7.5 to 8.0. In order for cacti to produce a beautiful bloom, they should be fertilized frequently.

3. Other Succulents

A large number of plants can be included under this heading. Succulents in this group may be classified as leaf and stem succulents. Leaf succulents can usually be identified by their thick, fat leaves and absence of stem. All of the life processes take place in the leaf of leaf succulents.

Propagation

Succulents can be propagated from stem cuttings, division, suckers, and seed. The specie and variety will determine the method to use. If seed are used, a bottom temperature of 75 to 80 degrees is recommended.

Leaf succulents require more moisture than stem succulents. A rule of thumb for watering succulents is to thoroughly water them twice a week during the growing season. However, they should not be watered on cloudy days.

A course, well-drained media is required for propagating, as well as growing. Equal parts of coarse sand, leafmold, and peat moss is one media mixture that may be used. Perlite at the rate of 10 percent of the volume may be mixed with the above mixture. The soil should be high in plant food, and the pH should be from 7.5 to 8.0. Lime is often added to the media, particularly if the specie being produced has white spines, stems, or leaves.

Diseases and Insects

Usually nematodes are the greatest insect problem in the growing of succulents. However, mealybugs and scale are present sometimes. Nematodes are controlled by cutting the knobs off the plant roots. Mealybugs and scale may be controlled by applying alcohol to the insects with a brush. Some succulents are sensitive to chemicals; therefore, a chemical application will damage the plants. This is true of plants that are members of the Crassula and Lithops.

REFERENCES:

1. Graf, Alfred Byrd, Exotic Plant Manual, Roehrs Co., East Rutherford, New Jersey, 1970.

2. "Selecting and Growing House Plants," United States Department of Agriculture, B-82.

Vocational Instructional Services
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CVAE AND VEH HORTICULTURE

Unit G: Growing Greenhouse Plants

Topic 9: Producing Plants For and Preparing Hanging Baskets

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Two or more laboratory exercises are presented in this topic.

1. Introduction

The demand for hanging baskets has mushroomed in a relatively short period of time and further increases in demand are expected. Hanging baskets are extremely popular with apartment and city dwellers who have limited ground level or floor space. They may be hung in any open or barren area.

Transparency No. 1

Containers for making hanging baskets are available from garden centers, greenhouse supply firms, nurseries, hardware stores, and other retail outlets. Clay, glazed clay, wire, plastic, and wood are materials often used in manufacturing commercial containers. A number of unused items found around the household can be made into hanging baskets. Some examples are steel helmets, teakettles, bean pots, teapots, hollow logs, and coffee cans. The arrangement of plants in the basket and the container used are limited only by one's imagination.

There are three principal considerations in the preparation of hanging baskets. These are (1) plant selection, (2) container selection, and (3) care and maintenance of plants. Each of these is discussed below.

2. Selecting Plants for Hanging Baskets

Many different kinds of plants may be used in hanging baskets. Location (inside or outside); whether plants are going to be exposed to partial shade, full shade, or full sun; humidity and temperature; size of plant(s); and size of container are factors to consider in making the plant selection. Another consideration for baskets going to be hung indoors is the amount of light, artificial and natural. Plant selection should be compatible with the environment in which they will be placed.

Some plants that may be selected for different areas are as follows:

Shaded Area	Full Sun	Partial Shade
Trailing begonias	Cacti	Vining impatiens
Philodendron	Vining geranium	Periwinkles
Hoya	Petunia	Airplane plants
Fuchsia	Tomatoes	Asparagus fern
Swedish ivy	Ice plant	Coleus
Wandering jew	Elephant plant	
Ferns		

3. Container Selection

The factors to consider in selecting containers are (1) size, (2) drainage, and (3) accent and blending of container with color(s) of plant.

The container should be large enough to support roots and foliage of plants and to allow space for plant growth. A 16 - inch container may weigh as much as 50 pounds after being filled with media and containing the plants. A 9 - inch container is normally considered to be adequate for a one - gallon container plant. If it is to be lined with sphagnum moss, a 12 - inch container is used for a one - gallon container plant.

Many of the glazed clay, plastic, and acrylic containers do not have drainage holes in their bottoms. These containers also do not allow the escape of air and moisture through their sides. Either drainage holes must be drilled in these containers or measures must be taken to prevent over watering. A carbon tipped drill bit and an electric drill can be used to drill holes in clay and glazed clay containers. A metal bit may be used for drilling holes in plastic and wood containers. The drilling speed should be very slow to prevent cracking the container. Two 3/8 - inch holes are usually adequate in a 10 - inch container.

Some containers are manufactured with knockout holes. The plugs from these holes are removed by placing a punch in the center of the plug and tapping the other end of the punch with a hammer.

If the hanging basket is to be located inside a house, a drip pan or a container that does not have holes should be used. Drainage materials must be placed inside of containers that do not have drainage holes. This material should occupy about one - fourth of the container. Pieces of clay pots, rocks, and horticultural grade charcoal may be used as drainage materials.

The container selected should accent and blend with the colors of the foliage of the plant(s). This will enhance the beauty and attractiveness of the hanging basket.

4. Care and Maintenance of Hanging Baskets

The key to the continued beauty and usefulness of the hanging basket is its care and maintenance. Water, fertility, shape and coverage of the plant, and light are the four principal considerations in their care and management.

Hanging baskets are generally exposed to greater amounts of light, wind, and sun. Therefore, the media dries faster. Watering will have to be more frequent than regular potted plants. During the summer months and the peak growing and blooming periods, they should be checked twice daily for moisture. If the media feels dry, the plants should be watered.

Plants in containers having holes in their bottoms should receive water until it runs through the holes. Plants growing in wire or plastic baskets should receive water for about two minutes after water is observed coming through the sides. The moss linings in these baskets do not absorb water very fast. They will however, in time absorb the excess water in the media. The water should be about the same temperature as the plants are exposed to.

Because of the necessity of frequent watering, the leaching of plant food is greater in hanging baskets. Hanging baskets should be fertilized about twice as often as pot plants. However, it is recommended that only about one-half of a normal application of fertilizer be applied. This prevents the possibility of injury because of over fertilization.

In order to get the desired shape and coverage, it may be necessary to prune the plants in hanging baskets. Pruning shears or a sharp knife may be used. When pruning, a clean cut is made just beyond a set of leaves. New branches will form at the cut. This process is continued until the desired shape is obtained. Once plants have the desired shape they are maintained in the same manner.

Hanging baskets should be turned periodically to provide uniform light for the plants. This will help maintain the uniformity of plant growth.

5. Potting Media for Hanging Baskets

The potting media must meet two requirements. It must be porous, but it must also have the ability to hold water.

Two types of potting media are used in hanging baskets. They are referred to as soil and soil - less mixes. Either can be used successfully if the recommendations for the plants and conditions are carefully followed.

A number of different soil mixes are being used successfully. Regardless of the ingredient used, the contents should be thoroughly mixed. Personal preference may dictate the mixture used. A commonly used mixture is composed of equal parts of loamy soil, sand, and peat moss. The peat is easier to mix when it has been dampened.

Soil - less media usually contains ground bark, vermiculite, and perlite. However, other inert ingredients may be used. Premixes are available from garden centers, but they are usually costly. The horticulturist would probably want to prepare the mixture used. Two cubic feet of a soil - less mix is sufficient for potting 20 to 22 12 - inch baskets or one - gallon containers.

6. Transplanting Into Hanging Baskets

One factor often overlooked in the preparation and transplanting of plants into hanging baskets is the cleanness of the basket. Only clean baskets or containers should be used. If it is necessary to clean the containers, warm soapy water should be used. All traces of soap should be removed from the container before starting to prepare the basket.

Wood and unglazed clay containers should be soaked in water overnight before receiving media and plants. This prevents them from absorbing the moisture in the media.

Transplanting Seedlings

Several days prior to transplanting seedlings to their permanent location, they should be hardened. This may be accomplished in one of several ways: (1) reduce the amount and frequency of watering. Water is withheld to just above the wilting point. (2) Gradually increase or decrease temperature. (3) Gradually shift plants to an environment similar to that of the permanent location.

The procedures to follow in transplanting seedlings are given below:

1. Media is thoroughly mixed, placed and firmed in basket or container;
2. A hole large enough to receive the roots of seedling is made in the media. (Seedling is placed about the same depth as it was growing in the propagation media.);
3. A case or putty knife is used to loosen the soil on each side and below the root zone of the seedling;
4. Seedling is lifted out of the propagation media with the knife, or by its top two leaves. (Seedlings are never handled by their stems because of the possibility of injuring them.) It is placed in the growing media immediately.
5. Soil is firmed around the seedling by applying pressure with the fingers placed around the seedling and applying pressure to the media;
6. Seedlings are watered;
7. Baskets are placed in a shaded area until the plants recover from the shock of transplanting; and
8. Media is kept moist for several days.

Transplanting Cuttings

New growth and hardening of the stems are indications that cuttings have developed new root systems. The safest method, however, of determining if cuttings are ready for transplanting is to remove a few cuttings and examine their root systems. The primary (first) roots should be one to two inches in length, and the formation of the secondary roots should have begun.

The procedures for transplanting cuttings are as follows:

1. Containers are prepared for accepting the growing media;
2. Media is placed in the container and firmed (the amount of media to put in the container depends upon the length of the cutting and the amount of rooting media that will be taken with the cutting.);
3. A hole large enough for the roots of the cutting and media to be taken with cutting is made in the growing media;
4. A cut is made in the rooting media around the cutting and about 3/4 inch from it;
5. The cutting is undermined with a knife and lifted out of the rooting media and placed in the growing media (The cutting should be planted about the same depth as it was growing.);
6. Soil is firmed around the cutting;
7. Plant is watered; and
8. Baskets are moved to a protected (shaded) area for a few days.

7. Preparing a Wire Basket

Wire baskets are used outside. The following procedures are used to prepare them for receiving plants:

Transparency No. 2

1. Basket is lined with sphagnum moss.
    a. Moss is soaked in warm water until it becomes spongy;
    b. Excess water is squeezed out of the moss;
    c. A piece of moss approximately six inches square is folded together with the shaggy sides outward;
    d. The folded moss is placed between the top two wires of the basket and firmly pressed against one of the vertical wires. (The springiness of the moss should hold it in place.);
    e. The above procedure is repeated until the top two wires are tightly packed the entire circumference of the basket (This will provide a tight, neat collar for the basket); and
    f. Remainer of basket is lined with moss in a similar manner.
2. A clay or aluminum pan is placed in the bottom of the basket. This prevents erosion of the media.

At this point if plants are to be planted in only the top of the basket, the basket is filled with media; and the seedlings or cuttings are transplanted. The following steps are when plants will be planted through the moss and on the outside of the basket.

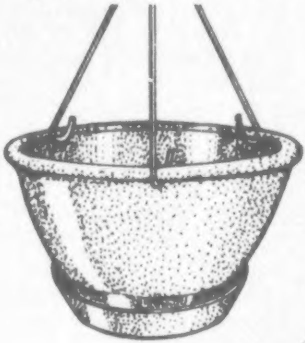
3. Approximately two inches of media are placed inside the basket.
4. A hole is made in the moss by separating it with the fingers. The hole should be large enough for the root ball to slip through.
5. The circumference of the basket is planted in this manner. All of the plants may be placed at the same level, or at different levels.
6. Root balls are covered with about two inches of media, and other layers of plants are planted from the outside of the basket in a similar manner.

7. Top of basket is planted with seedlings or cuttings.
8. Media is firmed around plants.
9. Plants are watered.
10. Basket is hung in a protected (shaded) location for several days.

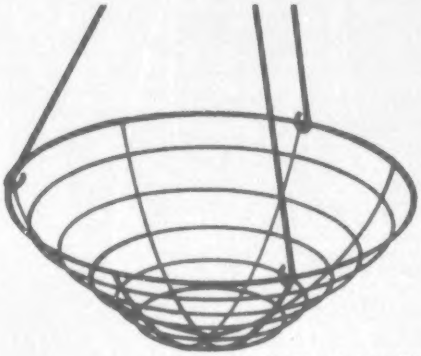
REFERENCE:

Bailey, Leo L., A Step - By - Step Guide to Landscaping and Gardening, Exposition Press, Hicksville, New York, 1974.

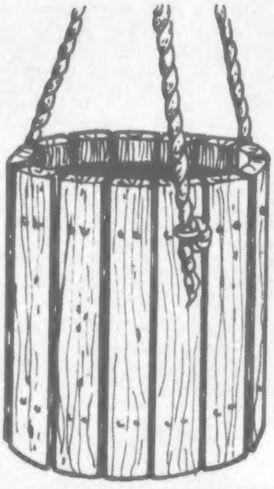
HANGING BASKETS & POTS



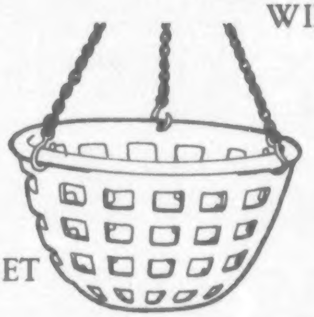
PLASTIC POT



WIRE BASKET

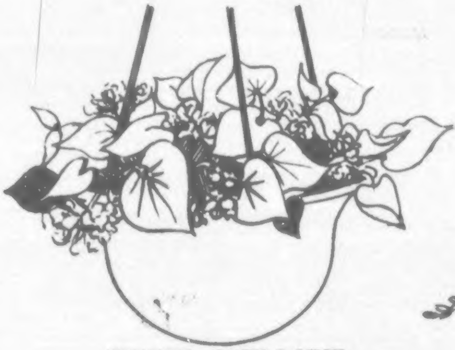


WOODEN BASKET

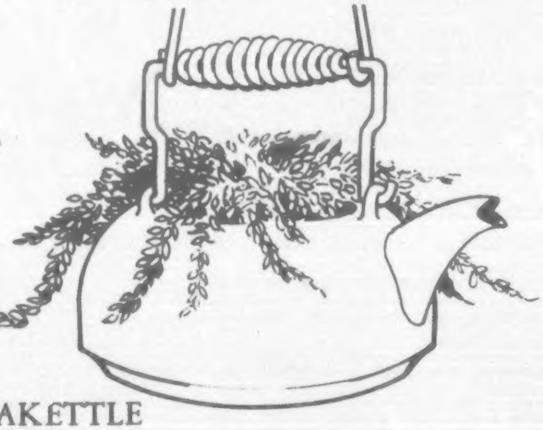


PLASTIC BASKET

NOVELTY BASKETS

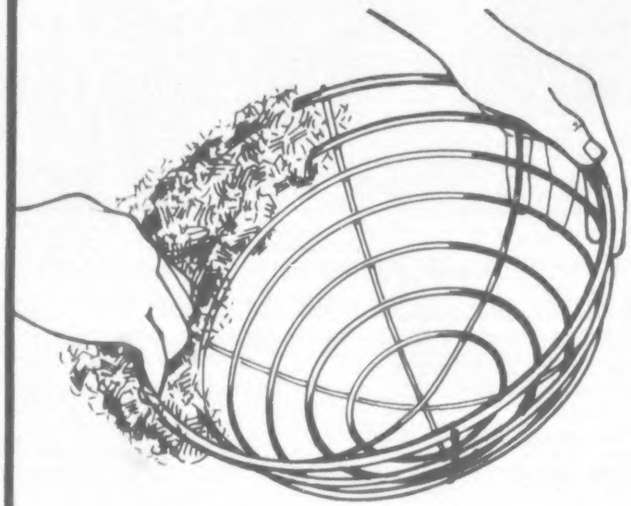


STEEL HELMET

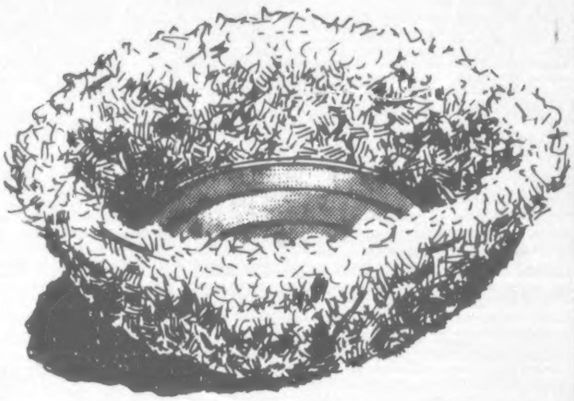


TEAKETTLE

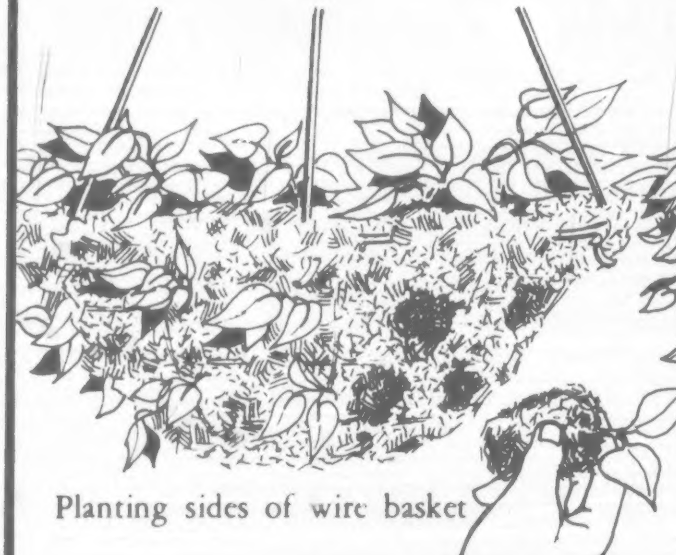
LINING & PLANTING WIRE BASKETS



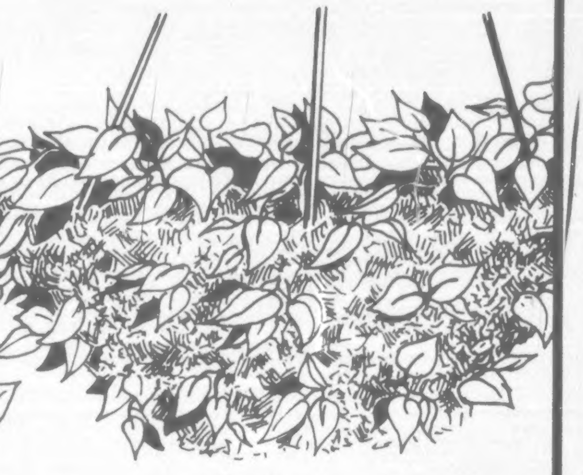
Placing moss around top two rungs of basket



Pan in center of lined basket



Planting sides of wire basket



PLANTED BASKET

CVAE AND VEH HORTICULTURE

Unit H: Nursery Plant Production

Topic 1: Growing Nursery Stock

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Several laboratory exercises are included in this topic. The teacher may wish to present the information while demonstrating the laboratory exercises. The publication "American Standards for Nursery Stock" is available from American Association of Nurserymen, 230 Southern Building, Washington, D.C. 20005, for those interested in plant standards or guides.

1. Nursery Soils

Since the primary objectives of a nursery are to produce and sell plants, the nursery soil probably has the most influence on the success of a nursery. The three soil factors affecting plant growth are (1) soil condition, (2) its organic matter content, and (3) level of fertility. These three factors are closely related, and soils that are in a good condition have a high organic matter content and level of fertility.

Soil condition can be determined by observing the soil. A soil in good condition will be granular and friable (easily crumbled or pulverized). An ideal nursery soil is one composed of silt and clay and bound into large aggregates (particles). This type of soil is well-aerated, absorbs water quickly, promotes micro-organism activity, and retains nutrients and moisture.

Generally, soils should be conditioned before planting nursery stocks. Clay soils normally are compacted and poorly aerated. Sandy soils have a tendency to dry out rapidly and are low in nutrients. Both are often low in organic matter content. The addition of organic matter improves the soil condition.

Organic matter content can be increased by several means: adding peat moss or manure or by growing green manure crops. Growing green manure crops is the most economical method. The crop is turned under or shredded while green. The residue is left on top of the soil to decay when shredded. If the crop is turned under, nitrogen is required during the decaying process and should be added to speed up decay. Other nutrients may be added at the same time. The amount of nutrients to add is determined by a soil test.

Time of plowing can affect the condition of nursery soil. Fall plowing improves the physical condition of the soil, permits residue and other materials to decay faster, more evenly distributes organic materials, and exposes insects and diseases to the weather.

Spring plowing helps control weeds and helps the soil hold and retain moisture. Spring plowing, however, can also increase the rate of moisture evaporation. To be the most effective, plowing in the spring should be at the proper time.

2. Lining Out Nursery Stock

Lining out refers to the planting of nursery stock. Since the stock is often planted in a line, it is called lining out.

The method used in lining out nursery stock is determined by the specie and kind of plant. Stock may be transplanted from propagation beds, transplant beds, or coldframes. Some plants, such as forsythia, can be taken directly from cold storage and lined in the field. Grafted plants may be handled in the same way.

Evergreens are often planted in transplant beds the first year and planted in the field the second year.

Seedlings are planted either in the fall or spring. Climatic and other conditions will affect the planting time.

The method and type of equipment used will depend upon the personal preference of the individual nursery owner. Furrow plows, trowels, lifting bars, transplanting machines, and spades are some of the equipment used in transplanting.

Following the lining out of plants in the nursery, they should be thoroughly watered. This is necessary for the elimination of air pockets in the soil and to firm the soil around the roots.

The spacing of nursery plants in the field is very important. The following chart includes the spacing recommendations for nursery stock planted in fields, transplant beds, and cold frames:

Type of Plant	Propagated by	Being Transplanted into	Recommended Spacing		Year
			Between Rows	In Rows	
Deciduous Trees					
Standard	Seeds	Beds	8-12"	4-6"	7
	Seeds	Field	3½-4'	2-3'	6-7
	Cuttings & Grafts	Field	3½-4'	2-3'	2-5
Small Trees	Cuttings & Grafts	Field	3½-4'	1-2'	2-5
Evergreen Trees	Seeds	Beds	4-10"	3-10"	3-6

Narrowleaf Evergreen Shrubs	Seeds	Beds	6-10"	3-6"	3-5
	Seeds	Field	3½-4'	4-5'	4-6
	Cuttings	Frames	6"	3"	3-5
	Cuttings	Field	3½-4'	2-3'	3-5
	Grafts	Frames	8"	4-6"	3-5
	Grafts	Field	3½-4'	2-3'	3-5
Broadleaf Evergreens	Seed	Beds	4-10"	4-10"	4-6
	Cuttings & Grafts	Frames	4-10"	4-10"	4-6
	Seeds, Cuttings, & Grafts	Field	3½-4'	2½-3'	4-6
Deciduous & Evergreen Vines & Ground Cover	Cuttings	Field	4'	12"	3

3. Watering Nursery Plants

The most critical problem in watering nursery plants is determining when to water. A number of factors affect the water requirements of plants. Some are the (1) temperature, (2) humidity, (3) soil condition, (4) type of soil, (5) age of plants, (6) length of time they have been planted, and (7) rainfall.

There are not any specific recommendations for watering that will apply to all situations. However, the following will influence water requirements. Young plants having a long growing period require more water than plants having only one flush of growth during the growing season.

Plants indicate their need for moisture by wilting. A slight wilt has little effect on the growth of plants, but a severe wilt reduces growth and can cause the plant to die. By the time a plant wilts, injury may have taken place.

The best method for determining moisture requirements is to conduct a soil moisture test. This is performed by removing a spade of soil from several locations in the field. The samples should be taken near the root zone of plants. The amount of available moisture is determined by how well the soil holds together at the deepest point. Dry soils will fall apart. Soils containing adequate moisture will form a ball when worked with hands.

4. Fertilizing Nursery Plants

A soil test should be conducted prior to the application of a commercial fertilizer. In addition to the soil test, plants indicate soil nutritional deficiencies. Poor growth and an abnormal color of foliage are indicative of nutritionally deficient soils.

Recent research conducted on the benefits received from fertilizer applications during different seasons of the year has revealed that deciduous plants receive the most benefit from commercial fertilizer when it is applied in the fall. The fertilizer should be applied after the leaves have fallen. The tops of the plants are dormant at this time, but the roots are still active. The nutrients are stored in the roots of the plant and are used by the plant in the spring.

The other season in the year in which it is recommended to apply fertilizer is during the spring. The fertilizer is applied either before or after the plants begin to grow. A midsummer application of fertilizer is not recommended because it will encourage a soft growth which is easily killed by winter weather. Since there is considerable variation in the weather from one part of the state to another, the exact time that fertilizer should be applied cannot be specified.

Trace elements lacking in the soil should be applied at the same time that the primary fertilizer elements are applied. Also, if the soil pH needs correcting, either lime or sulphur may be applied at the same time.

5. Pruning and Supporting Nursery Stock

The principal reason for pruning nursery stock is to induce the plant to develop the desirable form and a compact growth. Usually about one-third of the top of deciduous plants are pruned when they are set in the field. This causes the plant to produce shoots near the base of the plant.

Narrowleaf Evergreens

The rounded form of narrowleaf evergreens are pruned in about the same manner as deciduous plants. Upright narrowleaf evergreens, such as red cedar, Chinese juniper, and certain arborvitaes, should be pruned to form a single main leader. Both rounded and upright narrowleaf evergreens are pruned back to strong side shoots to induce a compact growth. Some nursery owners prune plants within this group before growth begins in the spring and again after the new growth is completed.

Broadleaf Evergreens

Broadleaf evergreens require less pruning than narrowleaf evergreens. Broadleaf evergreens should be pruned after flowering. The tips are pruned to induce a compact growth.

Fruit Trees

Fruit trees and small flowering trees are pruned after the first growing season to induce the development of a main leader. Following the second growing season, the tip of the leader is pruned to cause the development of three to five main branches at two to five feet above the ground. This also helps the plant develop a rounded form and keeps the fruiting branches close to the ground, which makes harvesting easier.

Standard Trees

Trees in this group are pruned to eliminate weak crotches and secondary leaders. Trees should develop one main leader and several main branches spaced 12 to 18 inches apart.

Trees that have a tendency to develop cracked leaders can be forced to develop straight trunks by cutting the cracked leader just above the ground and allowing a new leader to develop.

Supporting Trees

It is necessary for the nursery owner to stake some plants in order for them to produce a straight main leader. Wood, bamboo, or metal stakes may be used for this purpose. Grafted trees are normally staked to prevent the grafted union from being knocked or blown off.

6. Root Pruning and Cultivating Nursery Stock

Root Pruning

Roots of trees and shrubs naturally grow beyond the soil volume that can be moved with B & B plants, and they exceed the root spread that can be handled easily with bare-root stock. In order to keep the roots of nursery plants within a small area, the nursery owner root prunes trees and shrubs every 2 or 3 years. Root pruning increases the possibility that trees and shrubs will grow when they are transplanted. The proper time for root pruning is in the fall after the leaves have fallen.

Transparency No. 1

The nursery worker should have a knowledge of root growth distribution and dormancy and growth cycles of plants. A spade is the only piece of equipment needed to root prune. A circle with a diameter of about one-fourth the height of the tree is marked around the tree. The roots are cut by forcing the spade into the soil the full depth of the spade all around the plant and just outside the circle. Generally, plants are fertilized after being root pruned. A cupful of fertilizer is spread on the ground inside the circle. In large-scale operations, root pruning is usually done by passing a tractor-drawn, U-shaped blade under the rows of plants.

The numbers appearing under the plants in the above transparency indicate the number of growing seasons this plant has been in the nursery. The illustrations of the fourth and sixth growing seasons are of plants that have been root pruned.

7. Nursery Plant Culture

The cultivation of nursery stock is an important aspect of plant culture. In addition to killing weeds, cultivation breaks the soil crust and allows water to penetrate the soil more readily. This also reduces the loss of surface water.

The use of herbicides is often the most economical means of controlling weeds. Either granular or soluble forms of selected herbicides may be used. The time of application is dependent upon the kind of weeds to be killed. One of the methods used to kill weeds is to incorporate the herbicide in the soil before planting the nursery stock. If the herbicide is applied after the stock is planted, an effort should be made to prevent it from coming in contact with any part of the plant; otherwise, there is a possibility that the plant will be injured.

Since each group of horticultural plants require different cultural practices, a discussion of each group is given.

Deciduous Shade Trees

Most deciduous shade trees are propagated by cuttings or bud grafts. The bud grafts are placed on seedling root stocks. The small trees are lined in the fall as one-or two-year old plants. They are spaced about 18 inches apart in the nursery row. After about four years of growth in the nursery, every other tree is removed to allow for growing space. This will give about 36 inches of growing space per plant. The plants are root pruned every three or four years.

The trees are dug B & B or bare-rooted in the early spring while they are still dormant. Some nurseries dig the bare-rooted plants in early winter and place them in cold storage until they are sold in the spring.

Deciduous Flowering Trees

The culture of plants in this group is similar to that of the deciduous shade trees. They are propagated by budding, rooted cuttings, or grafting and are lined out as one- or two-year old plants. They may be grown with either one main leader or several leaders. They are root pruned in the third and fifth years, and the branches are pruned to give them the proper shape. Five to six years of growth are usually required before they are marketed. They are dug bare-rooted or B & B.

Narrowleaf Evergreens

Plants within this group are propagated from root cuttings, seedlings, or grafts.

The narrowleaf evergreens that grow upright are pruned to produce one main leader and a dense, symmetrical growth. They are root pruned in the third and fifth years of growth and are sold in the sixth year. They are dug B & B.

The spreading type of narrowleaf evergreens are grown in the same manner as the upright, but they are not pruned to produce one main leader. The laterals are pruned to produce a natural form. They are dug B & B.

Broadleaf Evergreens

This group of plants is propagated by cuttings, seedlings, or grafts. Broadleaf evergreens have shallow, dense root systems; therefore, they are not root pruned. They are dug B & B and sold after about five years in the field.

Vines and Groundcover

Most of these plants are grown as container stock. Those that are grown in the field are generally planted as rooted cuttings. They should be spaced 12 inches apart in the row. About three years of growth are required before they are marketed. They are dug bare-rooted or B & B.

Fruit Trees

Most of the plants in this group are propagated by budding. They are pruned to produce three to five main branches and are sold out of the field at three to four years of age. They are dug bare-rooted.

Small Fruits

Grapes and berries are included in this group. They are propagated by tip layering. They are dug bare-rooted and sold after growing one to two years in the nursery.

Seedling Trees and Shrubs

These are planted in rows six to eight inches apart and are dug bare-rooted as two- to three-year olds.

Bulbs, Corms, and Tubers

These are propagated from offsets or division. They are spaced in the row six to eight inches apart.

Herbaceous Perennials

Plants in this group are usually propagated by specialists from seeds, cuttings, or offsets. The larger growing plants within this group are grown from one to three years before being marketed, while the smaller growing plants are sometimes sold after four to eight months of growth. They are sold as bare-rooted plants.

8. Holding Nursery Plants

Since the roots of bare-root plants are easily injured when they become dry, they should not be allowed to dry out while in storage. Bare-rooted deciduous plants that are going to be held for a long period of time should be heeled-in.

Transparency No. 2

The plants are heeled-in by digging a trench 12 to 18 inches deep. The plants are placed in the trench as close as possible and with their tops pointing south. The trunk should be at a 45 degree angle to the ground. The plants are pointed to the south to reduce the drying of the tops and to prevent the trunks from sunburning. The soil which was dug from the trench is placed around and over the roots and lower part of the plants. The soil is watered and kept moist.

B & B nursery stock is also heeled-in if it is going to be held for a long period of time. Sawdust, wood shavings, or peat is used to cover the plant ball. A frame is used to hold the materials in place, and the plants are placed as close as possible in the frame in an upright position. The materials are kept moist.

9. Grading and Digging Nursery Stock

Nursery stock grades based upon certain measurements of specific parts of plants have been prepared by the American Association of Nurserymen. The measurements used are the trunk caliper, height of plants, and root spread or ball size. For various reasons, some nursery workers do not grade their plants.

Digging Bare-Rooted Plants

Deciduous plants are dug in the fall after having lost their leaves or during the winter or early spring while the plants are dormant. Tractor drawn equipment is used by larger nurseries to perform this task.

Following the digging of the bare-rooted plants, the nursery worker prunes the dead and broken roots and crossed branches. The plants are graded in the field or in a grading shed.

Digging B & B Plants

There are a number of different kinds of power equipment that may be used for digging B & B plants. They may also be dug by hand with a spade.

Transparency No. 3

The following is an explanation of the steps taken in digging B & B plants.

1. A piece of twine is used around the top of the plant to gently pull the branches in an upright position. The twine is tied with a square knot.

2. A circle is made in the soil around the tree. The diameter of the circle should be about 1/4 of the height of the shrub.

3. A trench is dug 12 to 16 inches deep from outside the circle. The back of the blade should be toward the plant as it is forced into the soil.

4. The circle is undercut as far as possible after the root ends of the plant are cut.

5. A piece of burlap large enough to enclose the soil ball is cut. One corner of the burlap square is tied to the trunk of the plant.

6. The burlap is drawn down one side to the base, tucked under the ball as far as it will go, and is pushed into a tight roll.

7. From the opposite side, the blade of the spade is used to cut the lowest roots. The ball is then tilted away from the worker.

8. The burlap is pulled under the bottom of the ball and wrapped tightly around it. Nails or pins are used to tie the burlap.

9. The end of a ball of twine is tied to the trunk of the plant. The twine is placed under the ball again at a right angle to the first pass. Then the twine is tied to the trunk of the plant. Several loops of twine are wrapped around the ball. The twine should be looped with vertical pieces of twine and tied.

10. The ball is lifted out of the hole with the spade. The ball should not be lifted by the trunk. A cracked ball will kill the plant.

The following table gives the recommended minimum size ball for five general types of plants. These recommendations are for plants that have grown under favorable conditions and have developed an average or better root system. For plants in the upper limits of the table, it is recommended that the ball size for the next larger plant be used.

Type 1 Spreading Conif. and Broadleaf		Type 2 Broad Conif. and Broadleaf Evergreens		Type 3 Columnar Conifer Evergreens		Type 4 Shrubs and Small Trees		Type 5 Standard Shade Trees	
Spread	Min. Diam. Ball	Height	Min. Diam. Ball	Height	Min. Diam. Ball	Height	Min. Diam. Ball	Cal.	Min. Diam. Ball
1½-2	11	1½-2	11	1½-2	11	1½-2	10	1¼-1½	18
2-2½	13	2-3	13	2-3	12	2-3	12	1½-1 3/4	20
2½-3	15	3-4	15	3-4	13	3-4	13	1 3/4-2	22
3-3½	16	4-5	17	4-5	14	4-5	15	2-2½	24
3½-4	18	5-6	19	5-6	16	5-6	16	2½-3	28
4-5	21	6-7	21	6-7	18	6-7	18	3-3½	32
5-6	24	7-8	24	7-8	20	7-8	20	3½-4	36
6-7	28	8-9	27	8-9	22	8-9	22	4-4½	40
7-8	32	9-10	30	9-10	24	9-10	24	4½-5	44
8-9	36	10-12	33	10-12	27	10-12	26	5-5½	48
		12-14	36	12-14	30				
		14-16	40	14-16	33				
		16-18	44	16-18	36				
		18-20	48	18-20	40				

Transparency No. 4

The different types of plants listed in the above table are shown in the above transparency. A listing of several plants of each type are as follows:

Type 1-Spreading conifers and broadleaf evergreens-Pfitzers Juniper, Spreading Yew, Globe Arborvitae, Cotoneaster, Rhododendron, Azalea, Pittosporum.

Type 2-Broad coniferous and broadleaf evergreens-Retinospora (fast-growing upright varieties), Norway Spruce, Hemlock, Pine, Magnolia, Laurel.

Type 3-Columnar coniferous and broadleaf evergreens-Arborvitae (upright varieties), Juniper, Holly, Yew (upright).

Type 4-Shrubs, small trees and ornamental grasses-Viburnum, Dogwood, Flowering Cherry, Hawthorn.

Type 5-Standard shade trees (deciduous and evergreen)-Maple, Oak, Birch.

Transparency No. 5

The ball depth ratio is a general recommendation, and it may be necessary in some instances to use balls that are larger. The ball size should be large enough (diameter and depth) to encompass the fibrous and feeding root system and to insure full recovery of the plant.

The depth of a ball with a diameter of less than 20 inches should not be less than 75 percent of the diameter. For example, a ball with a diameter of 10 inches should have a depth of at least 7½ inches.

Balls with diameters of 20 to 30 inches should have a depth of not less than 66 2/3 percent of the diameter.

The percentage of depth for larger balls should be scaled down proportionally to the diameter of the ball.

In areas where the minimum ball size recommendations cannot be applied due to soil conditions or other factors, the weight of the ball for various types and sizes of plants may be used. However, the weight of the ball is difficult to estimate unless the dimensions are determined.

Seedling plants growing in their native state experience more shock when transplanted than most nursery stock. A much larger ball than is recommended for nursery stock should be taken when digging these plants. The diameter of the ball should be at least 10 percent larger.

10. Planting Nursery Plants

The best time to plant trees or shrubs is during the dormant season; however, container and B & B plants have been planted successfully during most seasons of the year. Bare-root plants, however, should be planted in the dormant season.

Digging the Hole for Planting

The hole should be dug at least twice the volume of the root ball. In poor soils the hole should be even larger. The larger hole will allow for more soil and nutrients around the roots of the plant.

Transparency No. 6

The hole is dug deeper and wider than the ball, and the sides of the hole should be vertical or overhanging. Also, the sides of the hole should be irregular or roughened to prevent the hole from becoming a container similar to a pot. The roots of plants have a tendency not to penetrate the holes with smooth sides and to grow around the plant inside the hole.

The holes for bare-rooted plants should be dug wide and deep enough to prevent the cramping of the roots. The roots of bare-rooted plants should be spread out to full length to take advantage of as much moisture and nutrients as possible. From four to six inches of space should be allowed between the end of the roots and the sides of the hole.

Planting B & B, Bare-Root, and Container Plants

Transparency No. 7

After the hole has been dug, enough backfill materials or media should be placed in the hole to bring the top of the ball parallel with the ground level.

It is not necessary to remove the burlap, since it will decompose in a short time. However, several slits should be made in the burlap on the sides of the ball after the plant has been placed in the hole. Splitting the burlap will hasten root penetration.

After the plant has been placed in the hole, the topsoil or media should be refilled around the ball to within about two-thirds of the top of the ball. The soil should be tamped downward and under the ball to remove air pockets. The rest of the soil may be firmed with the foot. The hole is then filled with water, and the water is allowed to penetrate the soil. Then the hole is filled to ground level, and the top of the ball is covered with a small amount of soil. The subsoil is used to construct a water ring two to three inches high around the outside of the planting hole.

Transparency No. 8

The bare-rooted plant must have its roots spread out to full length. The damaged part of the roots should be pruned, and the top is usually pruned to balance the top with the root system. The amount of pruning is based upon the loss of roots.

Enough fertile soil or media is placed in the bottom of the hole to allow the tree to be planted at the same level as it was growing originally. The plant is placed in the hole on top of the media, and the hole is filled within three inches of the top with soil. The soil is firmed around the roots. The soil is watered, and the water is allowed to penetrate the soil. Then more soil is added to the hole. This soil should be left loose and sloping toward the base of the plants.

Plants should not be planted too deep. When planted too deep, plants develop a new root system and become weakened. Some plants, such as azaleas and camellias, should be planted one to two inches higher than ground level.

Transparency No. 9

A container that will not decompose in a short period of time should always be removed from the plant before it is planted. The plant should receive as little shock as possible when removing the container. If the soil around the plant is not dry and the plant is not overgrown, small plants can usually be removed by inverting the can and knocking it lightly against an object. Mature plants growing in small containers may be removed by making cuts to the sides of the container. The cuts should be made on the opposite sides of the container.

Plants are removed from larger containers (10 gallon or larger) by cutting out the bottom of the container with a hatchet. The plant is then positioned in the hole, and the sides of the can are removed by cutting the sides in several places with a can cutter.

LABORATORY EXERCISE NO. 1

Activity: Heeling-in nursery plants (Bare-rooted and B & B plants)

Materials:

Spade or shovel (for bare-rooted plants)
Woodshavings or sawdust (for B & B plants)
Frame, size to be determined by teacher
  (for B & B plants)
Bare-rooted plants
B & B plants
Hose for applying water

Procedure:

This can be either one or two laboratory exercises. Since the procedures for heeling-in both types of nursery plants are explained in detail in the technical information, they are not repeated.

LABORATORY EXERCISE NO. 2

Activity: Digging B & B plants

Materials:

Spade
Burlap
Twine
Nails or pins
Plants

Procedure:

The procedure is explained in the topic.

LABORATORY EXERCISE NO. 3

Activity: Digging a hole for a plant

Materials:

Spade

Procedure:

The procedure is explained in the topic.

LABORATORY EXERCISE NO. 4

Activity: Planting a B & B plant

Materials:

Spade
Hose
B & B plant
Media (if used)

Procedure:

The procedure is explained in the topic.

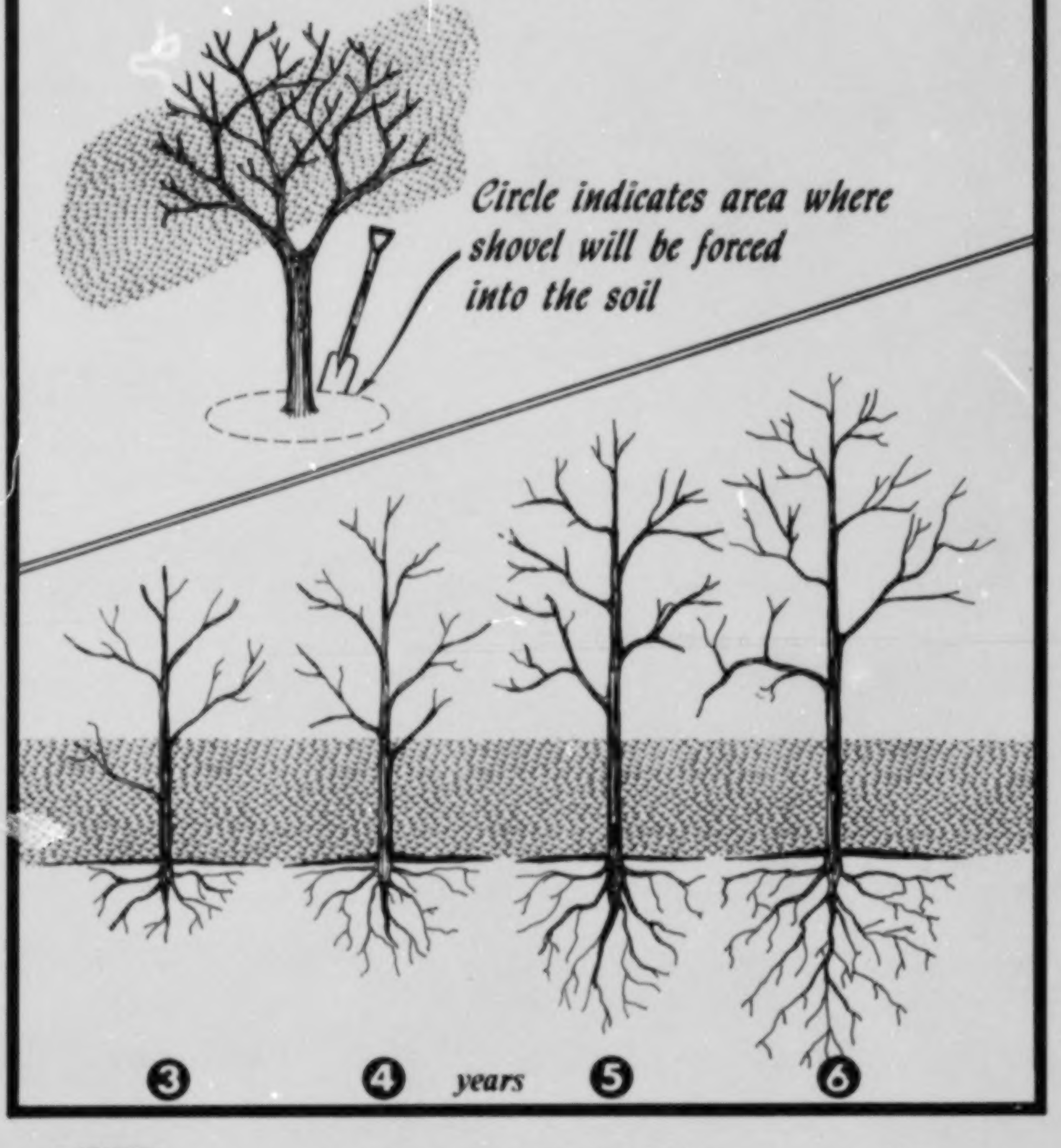
REFERENCES:

1. "Nursery Production," Vol. 12, No. 4s, College of Agriculture, Pennsylvania State University, University Park, PA.

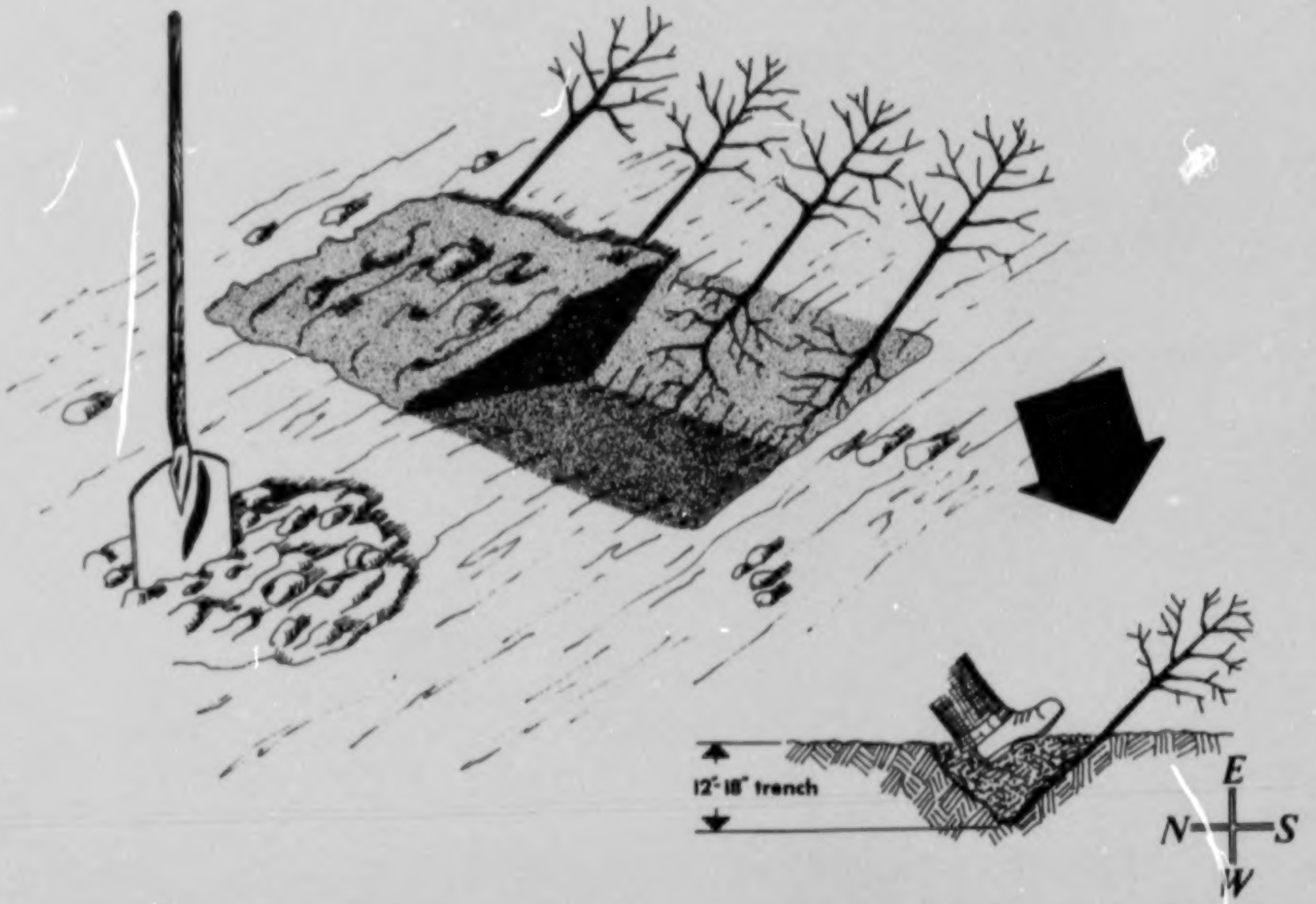
2. "Landscaping the Home and School Grounds," Vocational Education Media Center, Clemson University, Clemson, SC.

3. "Landscape Maintenance," Vocational Education Productions, California State Polytechnic College, San Luis Obispo, CA.

EXAMPLES OF ROOT PRUNING


Circle indicates area where shovel will be forced into the soil
3
4
years
5
6

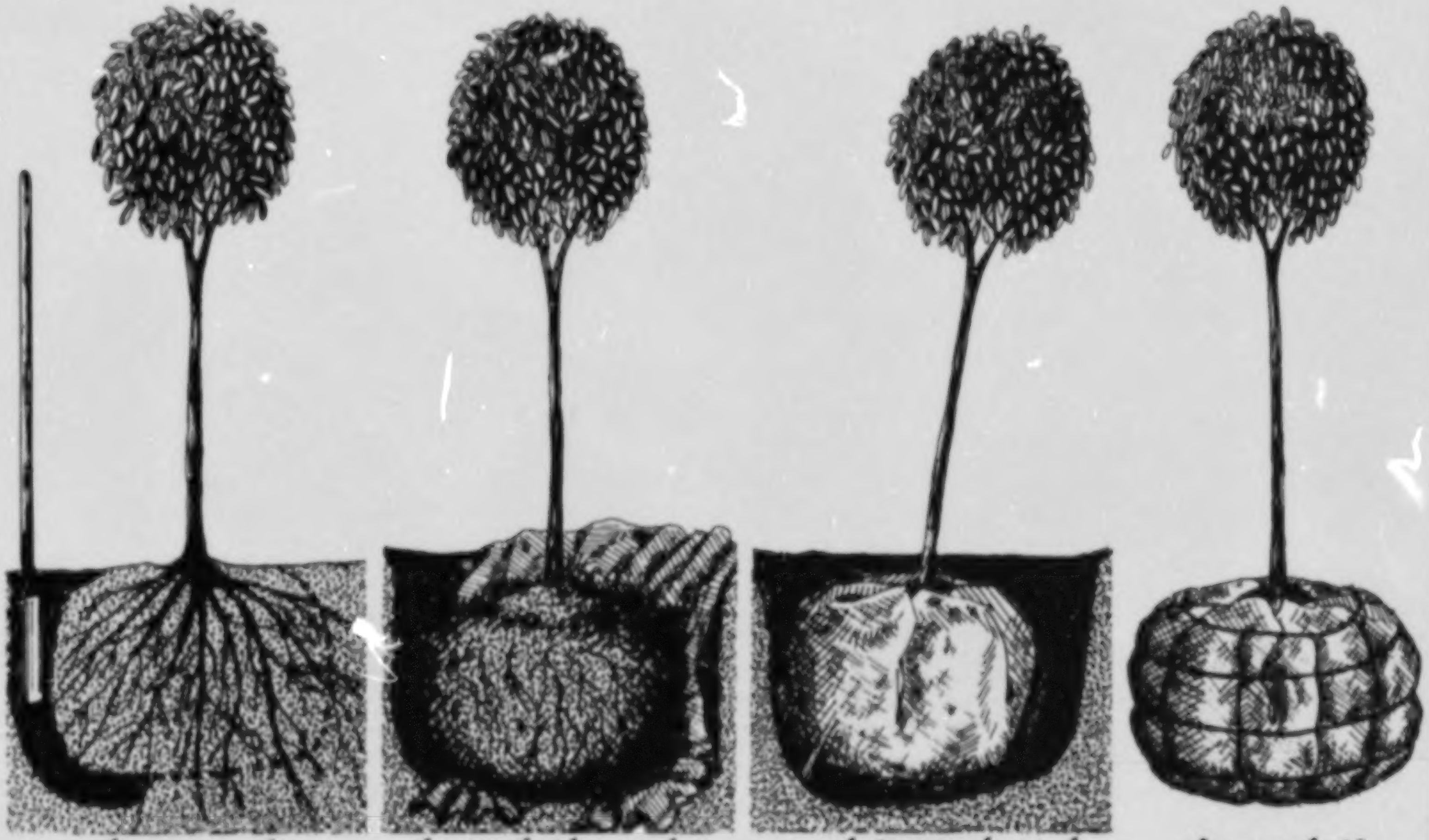
HEELING-IN


12"-18" trench
E
N
S
W

Pre-Lab, CVAE and VEH Horticulture

H-1
No. 2

DIGGING BALLED & BURLAPPED PLANTS



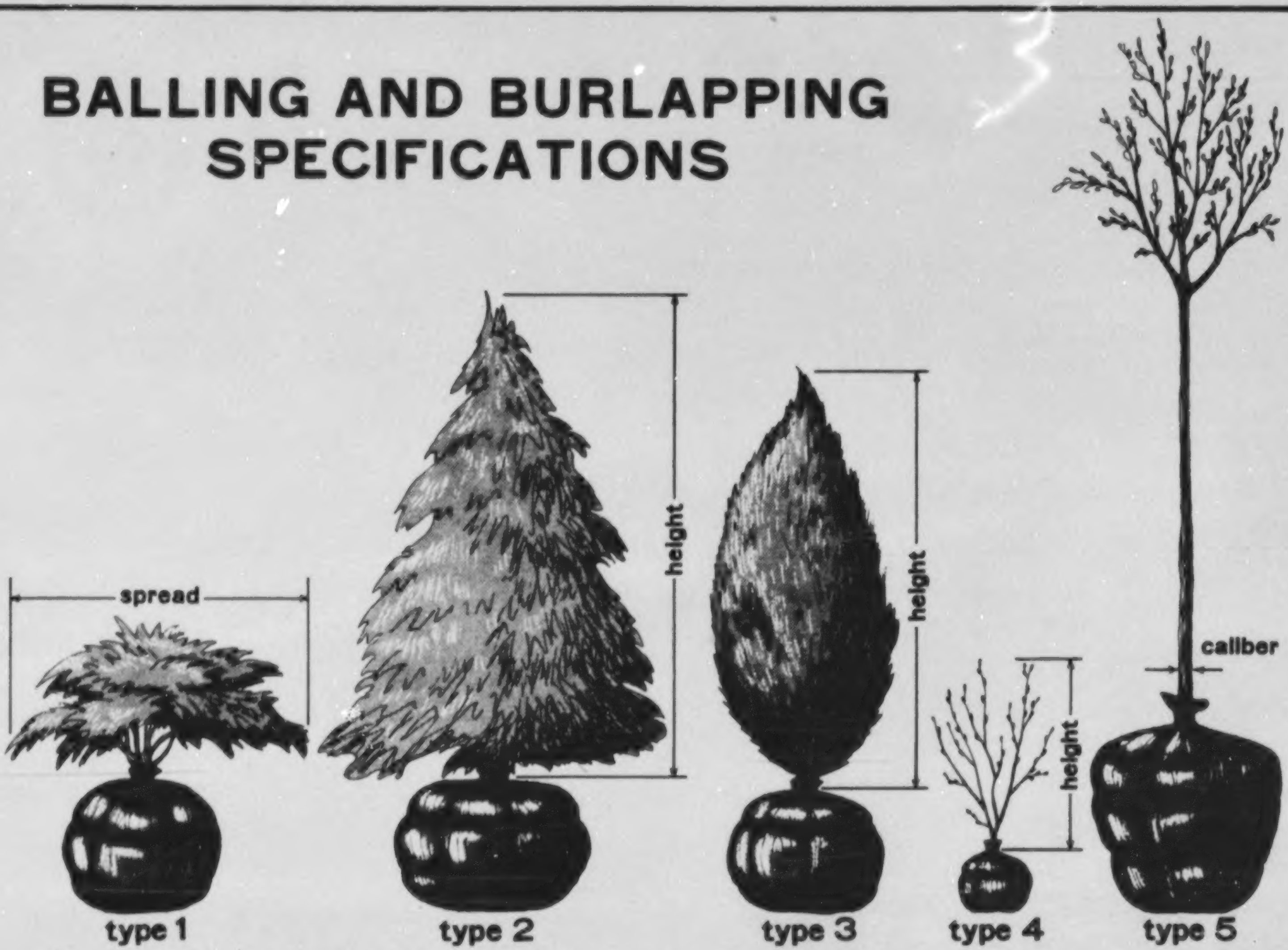
shape and undercut ball

place cloth under and around ball

complete and enclose

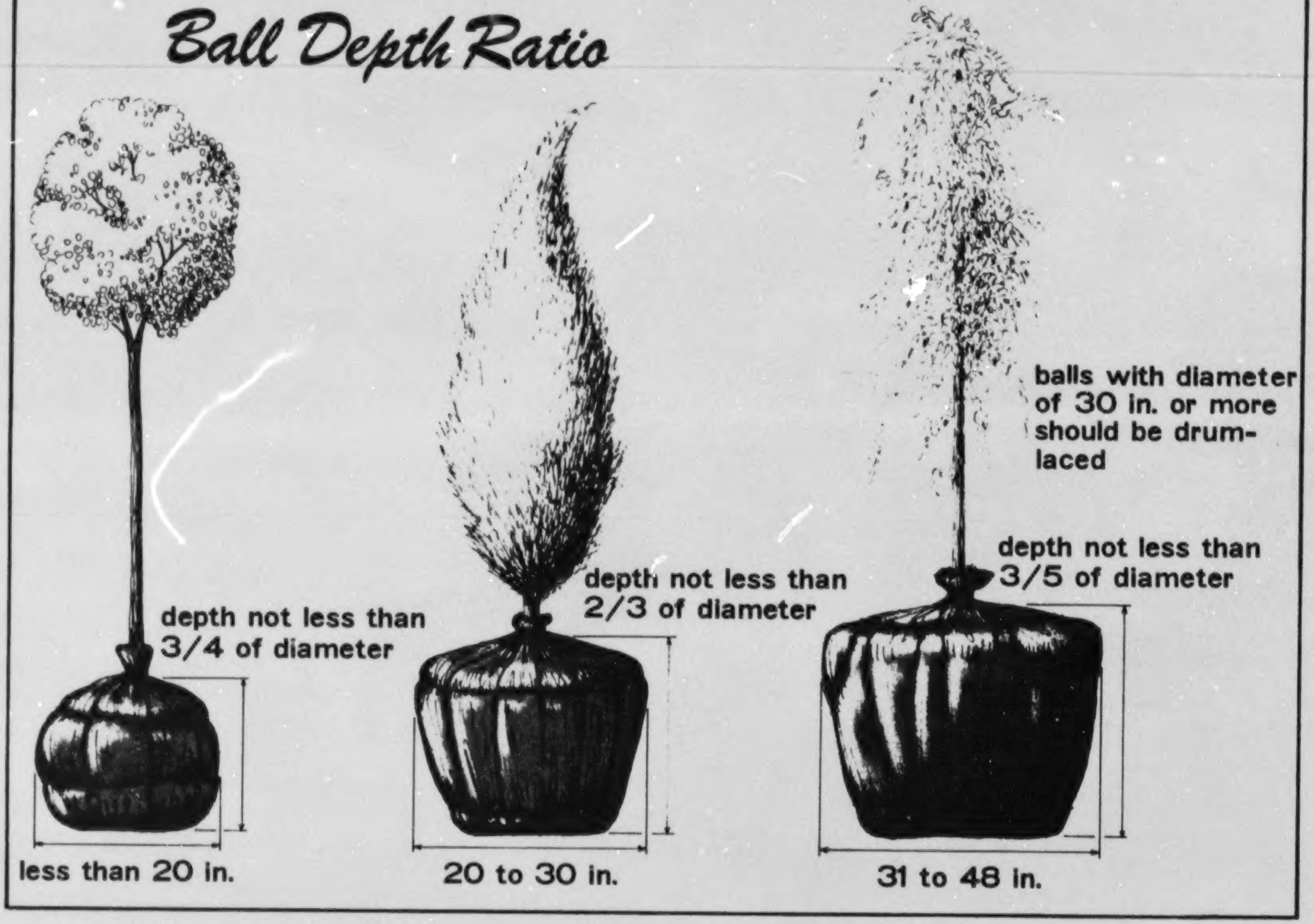
pin and tie

BALLING AND BURLAPPING SPECIFICATIONS

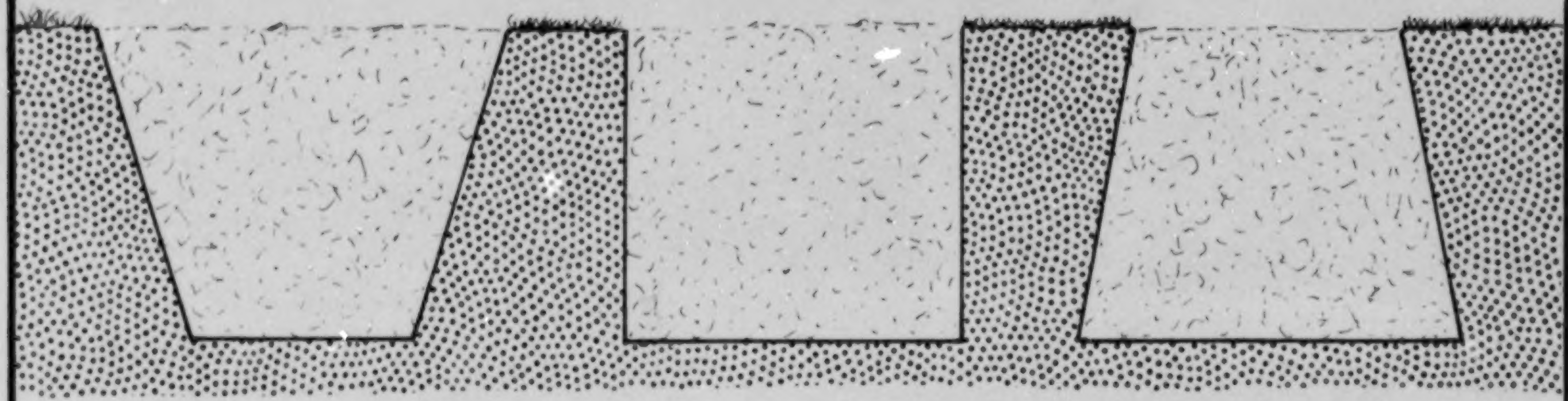

spread
height
height
height
caliber
type 1
type 2
type 3
type 4
type 5

DETERMINE MINIMUM BALL SIZE FOR EACH TYPE AND SIZE FROM TABLE

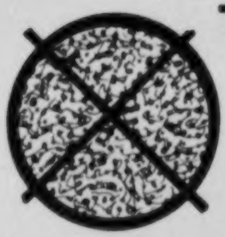
Ball Depth Ratio


depth not less than 3/4 of diameter
less than 20 in.
depth not less than 2/3 of diameter
20 to 30 in.
balls with diameter of 30 in. or more should be drum-laced
depth not less than 3/5 of diameter
31 to 48 in.

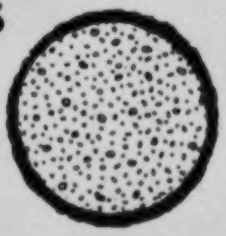
HOLES FOR PLANTING


INCORRECT
BETTER
CORRECT

TOP VIEW OF HOLES

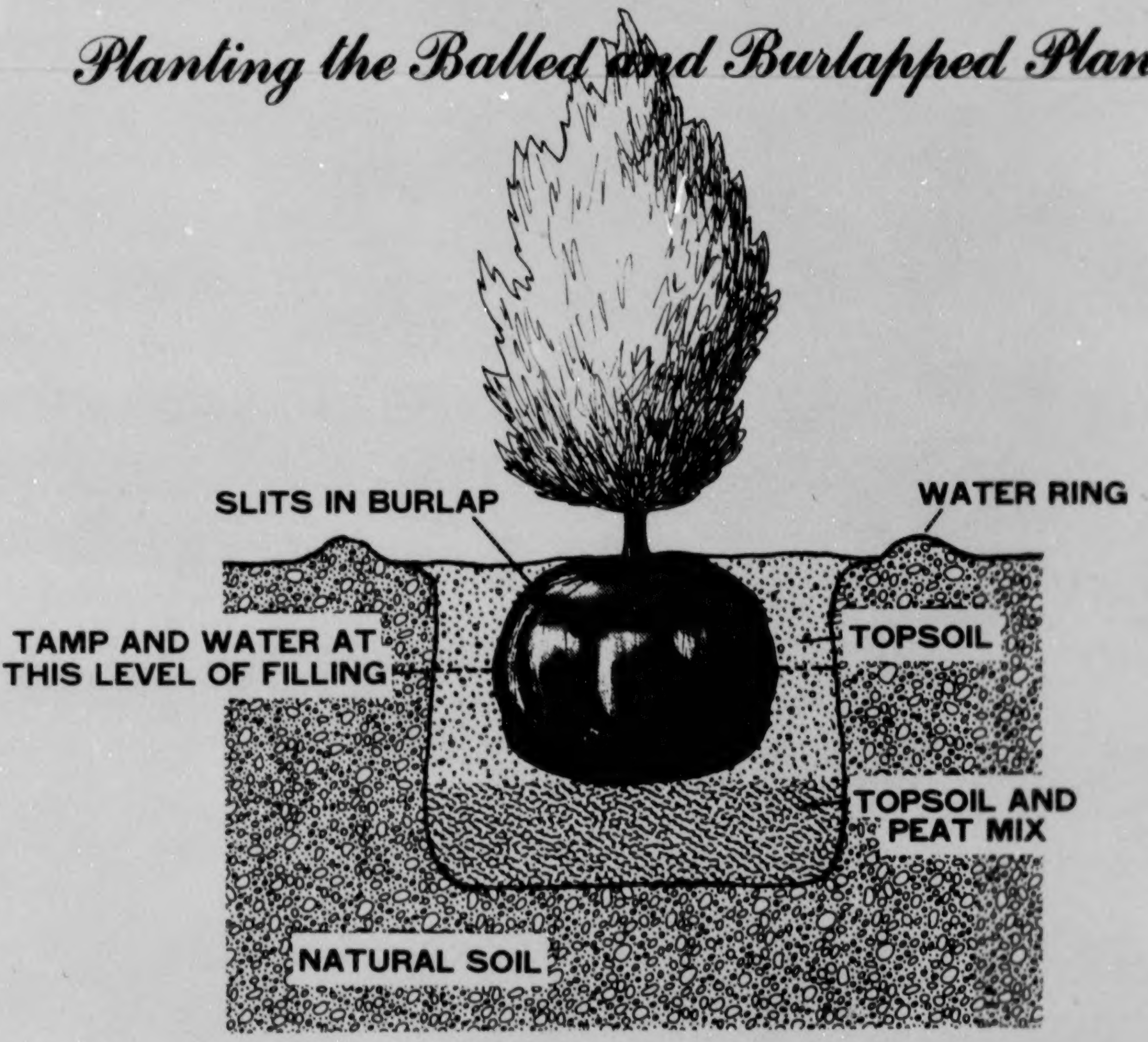


tightly packed dirt

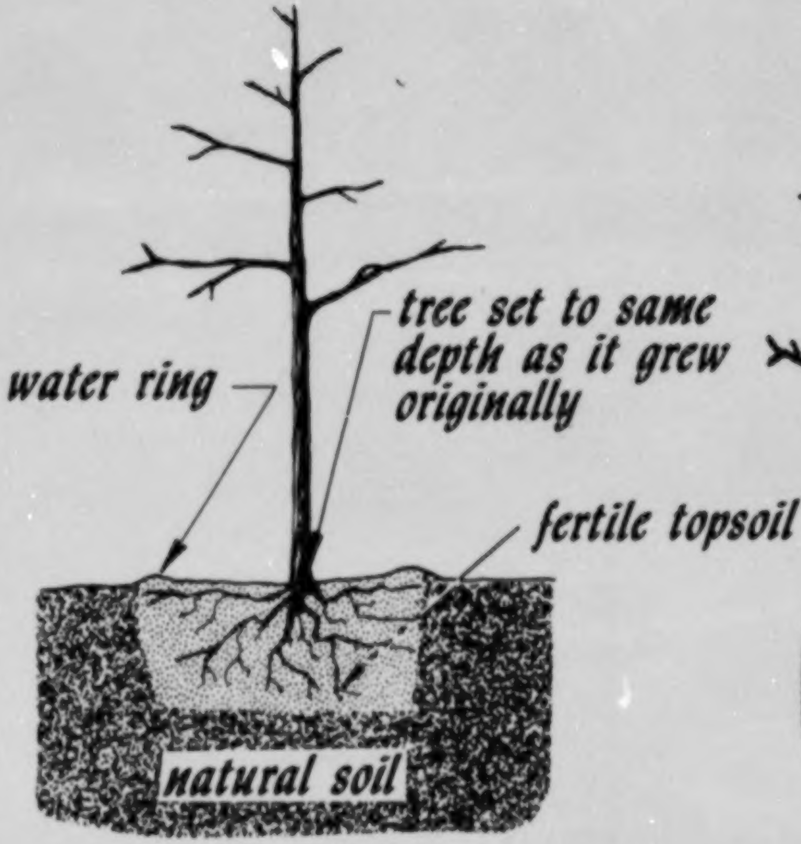


loosely packed dirt

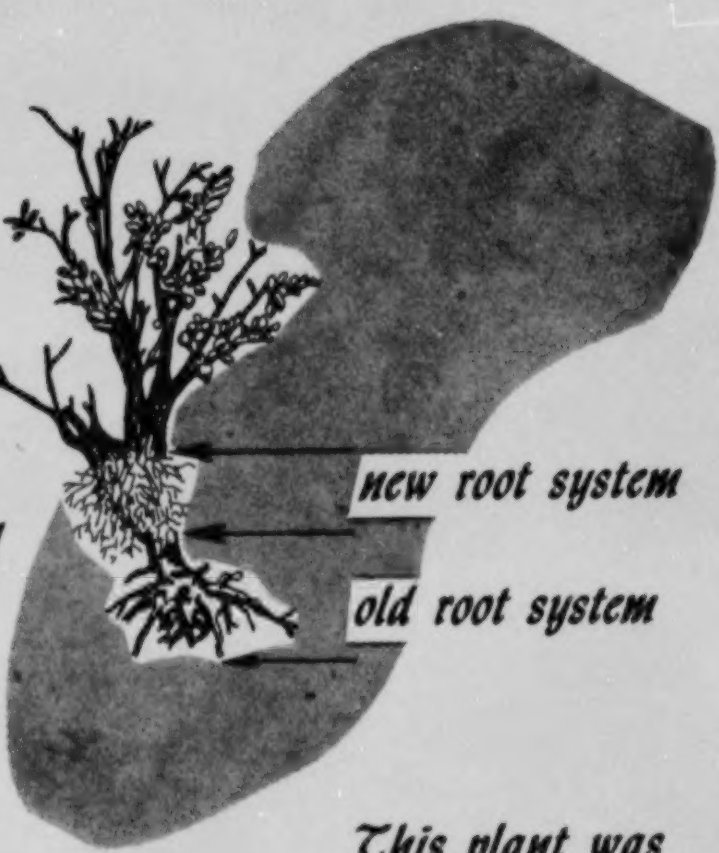
Planting the Balled and Burlapped Plant


SLITS IN BURLAP
WATER RING
TAMP AND WATER AT THIS LEVEL OF FILLING
TOPSOIL
TOPSOIL AND PEAT MIX
NATURAL SOIL

PLANTING BARE-ROOT PLANT

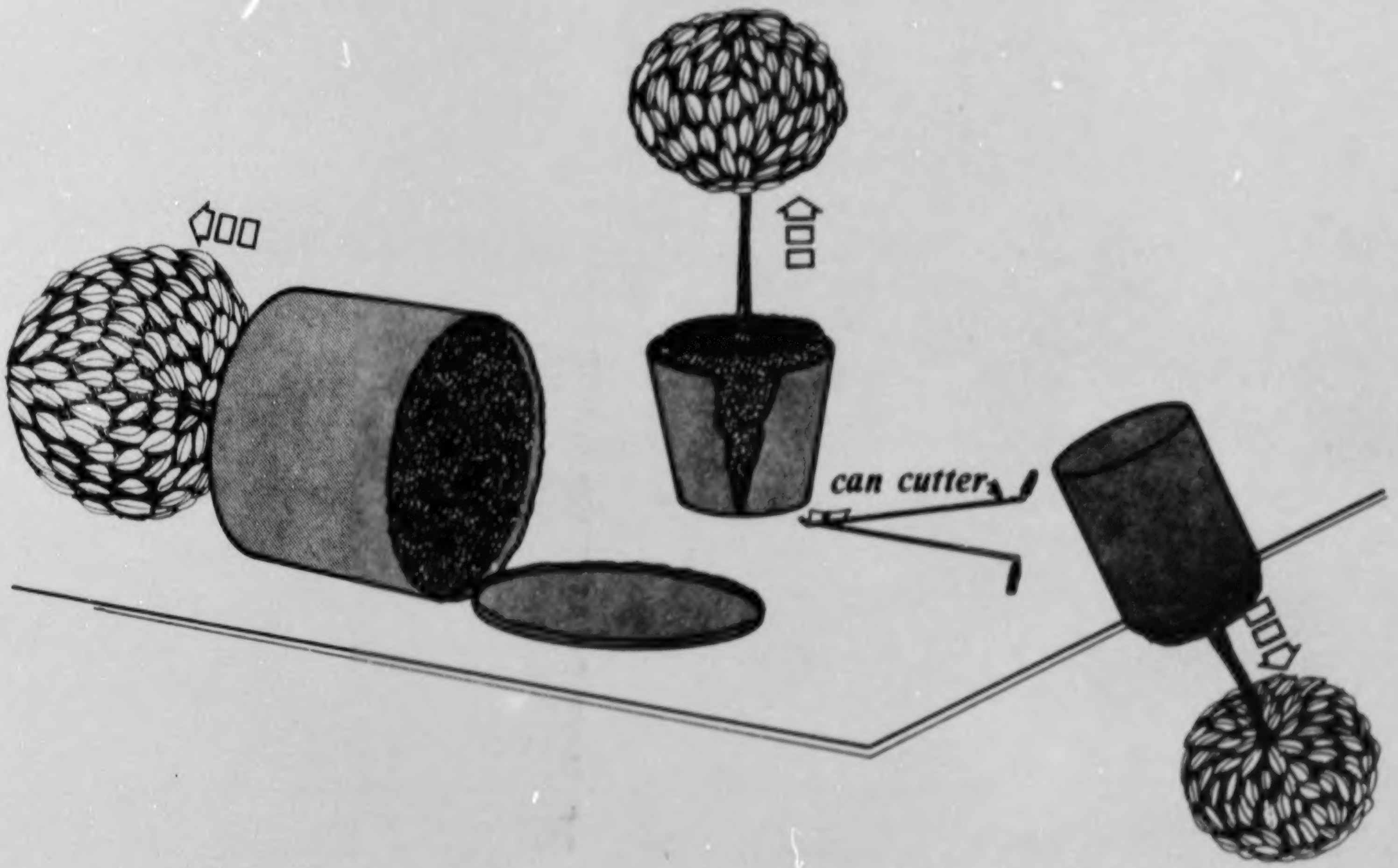

tree set to same depth as it grew originally
water ring
fertile topsoil
natural soil

Small tree planted bare-root


new root system
old root system

This plant was planted too deep

REMOVING PLANTS FROM CONTAINERS



Vocational Instructional Services
Agricultural Education

H-2
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit H: Nursery Plant Production

Topic 2: Growing Ornamentals in Containers

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Much of the information in this topic is included for the teacher, and the teacher may not wish to cover all of the materials in class. However, it is suggested the areas on the crop plan, growing media, planting of plants and the application of water and fertilizer be covered; and if possible a demonstration should be given on performing each of the tasks in each area.

1. Growing Nursery Stock in Containers

Container production of nursery stock is gradually replacing the field culture of ornamental and nursery crops. Even nurseries having large acreages of field grown plants are starting to produce container grown plants.

Transparency No. 1

There are a number of advantages in producing container grown plants:

1. More plants may be grown in a given area;
2. The plants are easier to handle;
3. The media used in containers is lighter than soil;
4. The planting season is longer;
5. Less labor is required (digging is eliminated; roots are not pruned);
6. Some plants are easier to grow in containers;
7. The plants can be sold when they are the most attractive;
8. Plants are easier harvested;
9. Growing conditions are easier to control (environment, weeds, insects, and diseases);
10. Fewer plants are lost from transplanting; and
11. Container plants are better suited for marketing by some retailers.

There are also some disadvantages in producing container grown plants:
1. A large quantity of media is needed;
2. Special equipment is usually required to water and fertilize the plants; and
3. There are no standards and grades for container plants.

Many students of horticulture do not understand the difference between "container stock" and "potted stock." Container stock is grown in the container until it is marketed, while potted stock may be seedlings, cuttings, or recently grafted plants grown for a period of time in small pots and later planted in containers or lined out in the field.

Container Production Area Layout

Several factors should be considered in selecting an area in which to produce container plants. Water must be available in large quantities, and the area should have good air drainage. Also, the surface drainage should be good. After the site has been selected, the area layout should be considered. Some of the factors to consider are listed below:

1. Loading of plants-The layout should be arranged so that the plants can be loaded directly from the growing area.
2. Roadways in growing area-The roadways should be constructed of sufficient width to allow for passing of vehicles and capable of withstanding heavy loads in all types of weather.
3. Width and length of beds-The width and length of beads should be planned for utmost efficiency in the use of machinery, equipment, and labor. Long, narrow beds with enough space between them for the efficient operation of trucks and other equipment appears to be the most efficient.
4. Plant area surface-The type of bed surface that will be used for growing plants should be carefully considered. A number of materials may be used for the surface. The bare ground, crushed rock, and black plastic or roofing felt are some of the recommended surfaces. There is a weed control problem when the bare ground or crushed rock is used. There also may be a problem with the roots of the plants growing through the containers and into the soil. When the plants are moved, they are damaged. Bare ground may not provide good drainage and may cause the plant to grow poorly. The use of plastic overlaid with 6 inches of rocks makes an ideal surface, but it is expensive. Weeds are controlled and the plant roots usually are contained in the containers with this type of surface. Being more permanent, roofing felt may be used as a substitute for plastic, but it is more expensive.

2. Container Selection

There is a large selection of containers available for the production of container grown plants. Most of the containers used by the industry are made of either metal, plastic, or paper. Metal containers have the advantage of being more durable, but they are also the most expensive. Metal containers work well with machine "canning" operations. Plastic containers will not rust and are probably more attractive. Paper containers are not recommended for the production of plants that will remain in the container for a long period of time. Paper containers are used by a number of nurseries in the production of bedding plants propagated by seeds.

There is one disadvantage in using metal containers. They are rapid conductors of heat and cold. Since there is a tendency for plant roots to grow between the growing medium and the inner wall of the container, rapid temperature changes of the metal surface can be injurious to the root system.

Sizes of containers available are 1, 2, 3, 5, 10, and 12 gallon.

The color of the container is very important. Some colors attract attention, and some distract attention. The customer's attention should not be distracted from the plant. Light gray or light green containers will not distract the customer's attention from the plant. Dark colored containers should be avoided because they absorb heat. Bright colored containers are difficult to keep clean and attractive.

Some nursery workers are of the opinion that certain plants grow better in a particular type of container. The grower's experience may be the basis for determining the type of containers to use.

Another factor to consider in selecting containers is the shape. The shape affects the storing and handling. Containers tapering from top to bottom are easier to store, require less storage (they can be stacked on top of each other), and the plants and media are easier to remove.

3. Crop Plan

Generally container plants are grown for a two-year period; however, some plants can be produced and marketed in one year.

Slower growing plants may require a longer growing period. The following schedule indicates the size of plants in inches across the top), size of container, and production time for different groups of plants. This schedule may not apply to all areas of the state.

Plant Group	Size Plant (top diameter)	Size Container	Production Time, Years
Small deciduous trees	12-15" (height)	6" can	2
	15-18" (height)	6" can	2
	18-24" (height)	8" can	3
	2-3' (height)	8" can	3
Narrowleaf evergreen shrubs	9-12"	6" can	1
	12-15"	6" can	2
	15-18"	8" can	2
	18-24"	10" can or 1 peck basket	

Plant Group	Size Plant (top diameter)	Size Container	Production Time, Years
Large broadleaf evergreen shrubs	10-12"	6" can	1
	12-15"	6" can	1
	15-18"	1 peck basket	2
	18-21"	1 peck basket	2
	21-24"	1 peck basket	3
	24-30"	½ bu. basket	3
	30-36"	½ bu. basket	4
	36-42"	½ bu. basket	4
Medium deciduous	12-15"	8" can	2
	15-18"	8" can	2
	18-24"	8" can	2
	24-30"	10" can	3
Medium broadleaved evergreens	12-15" (height)	8" can	2
	15-18" (height)	8" can	2
	18-24" (height)	8" can	3
	24-30" (height)	10" can	3
Small deciduous shrubs	9-12"	6" can	2
	12-15"	6" can	2
	15-18"	8" can	3
	18-24"	8" can	3
Small broadleaved evergreen shrubs	12-15"	6" can	2
	15-18"	8" can	3
	18-24"	8" can	3
Deciduous and evergreen vines	12-15" (height)	6" can	1
	15-18" (height)	6" can	1
	18-24" (height)	6" can	2
	24-36" (height)	6" can	2
Deciduous and evergreen groundcovers	12-15"	6" can	1
	15-18"	6" can	2
	18-24"	6" can	2
Garden flowers, herbaceous perennials		6" can	1

The spacing of containers is important in the production of plants because it affects plant quality and growth. Plants are usually spaced for the first year with their leaf tips barely touching. This spacing allows for good quality and a compact growth. If the plants are spaced too close, the lower foliage will turn brown; and the growth will be spindly. The second year they are spaced the same distance as the diameter of the container.

Transparency No. 2

The first example illustrates the "pot tight" spacing of 30 plants. The back dots indicate the pots which are not moved the second year.

The second example shows the nine pots which were not moved and the second year spacing of the other 21 containers. The containers are spaced a container diameter apart. Three times as much space is required the second year as the first year. Crops requiring a growing period of more than two years are usually kept at the same spacing as the second year of growth.

When determining the crop production, the grower must decide the number of plants of each kind he will need each year, the size of plant he wishes to produce, and the amount of space that will be needed. A detail plan, drawn to scale, should be made of the nursery space requirements.

Transparency No. 3

Factors to consider while making the crop plan are as follows:

1. Planting schedule-This should include number and kinds of plants that will be grown and the planting dates.
2. Number and sizes of containers needed
3. Quantity of media needed
4. Irrigation system requirements
5. Fertilizer injector system requirements
6. Man-hours of labor needed
7. Building space and equipment and tools needed
8. Production area layout

4. Growing Media

The media used in growing container plants has a lasting effect on the growth and development of plants. The media used should be well-drained; retain moisture and nutrients; hold moisture; have the proper pH for the plants being grown; be free of insects, diseases, and weeds; readily available, inexpensive, and easily reproduced; adapted to mechanical potting; light; and fail to deteriorate from sterilization or build up a toxic residue.

One standard media mixture cannot be recommended for all nurseries. The mixture will depend upon materials available and the individual situation. A general recommendation for a media mixture is one part of soil, one part of sand, and one part of peat. The peat will provide good moisture retention, while both peat and sand will provide good drainage and aeration. Sawdust, ground corncob, peanut hulls, and other organic materials which are available locally are used as substitutes for all or a part of the peat. Other materials used in media mixtures are sphagnum moss, peat moss, vermiculite, perlite, and leafmold.

Clay is added to the media used by some nurseries. The clay holds moisture and reduces the air spaces in the soil. A reduction of the air spaces prevents some plant root damage caused by freezes.

A cement mixer is used by some nurseries to mix media. Also, a flail type manure spreader is an economical method of mixing large quantities. About six cubic yards can be mixed in a minute with the manure spreader.

5. Planting Container Grown Plants

Most container grown plants are planted in the containers by hand in late winter or early spring. Root cuttings, one-year old seedlings, dormant unrooted cuttings, dormant grafts, and pot grown plants are used for stock. The stock may be propagated by the nursery or purchased from propagation specialists.

The potting operation is usually more efficient when assembly line principles are applied. Semiautomatic potting machines are available for large operations. An efficient five-man crew should be able to plant, water, and place in beds 12,000 plants per day after they become familiar with the procedures used. The five-man crew is used as follows: two men fill pots with media, two men plant, and one man waters. The entire crew is used to place the pots in beds.

The containers are filled with media to within 3/4 to 1/2 inch of the top of the container. This small amount of space is left to accumulate water. Plants are placed in the center of the container to the depth in which they grew originally. The media is firmed around the roots.

6. Watering Container Plants

An adequate supply of quality water must be available to properly grow container plants. A plant growing in a one-gallon container may require as much as one pint of water per watering. According to one estimate, an acre of container plants could require as much as 40,000 gallons of water. Before water is used on plants, it should be analyzed.

The amount and frequency of watering can vary considerably. The grower should examine the plants several times a day to determine when to water. When the soil surface in the container becomes dry to the touch, the plants need to be watered.

A sufficient amount of water should be supplied to allow a slight excess to flow out of the drainage holes in the containers. The frequency of watering varies depending upon the season of the year. It may be necessary to water as often as twice a day during the summer, while during the winter once a week may be adequate.

Factors that will influence the frequency of watering are as follows:

Transparency No. 4

1. Growing media
2. Size of containers
3. Materials from which the containers were constructed
4. Size of plants
5. Kind of plants
6. Season of the year
7. Weather conditions

Container plants should be grouped so that all the plants in an area will need water at the same time. Plants are grouped according to specie, size of plant and container, and kind of growing media. Since it is not economical to water a large number of plants by hand, an automatic or semi-automatic watering system should be used. The use of one of these systems is helpful in growing uniform plants. Each plant receives the same amount of water and nutrients.

Transparency No. 5

The system shown in the above transparency is used by nurseries to grow large plants in 15 gallon containers. The size of the supply lines are reduced at intervals from the main to maintain an even rate of flow at all points in the system. A plastic nozzle which gives a flat spray in a quarter-circle pattern is mounted at the end of each 1/8-inch plastic tube. The nozzle is held in place by a wooden stake driven into the ground at the edge of each container. The containers are spaced on four-foot centers. A system having 25 P.S.I. can deliver two gallons of water in five minutes.

The mains could be placed in every other row and a small plastic tube run to the plants on each side of the main. This leaves alternate rows clear for workers.

7. Fertilizing Container Grown Plants

The fertilizer can be incorporated with the media for plants grown in containers for a short period of time. Most container grown plants require more nutrients than can be applied to the media in which it is growing. For rapid, vigorous growth, plants require a non-fluctuating supply of nutrients at all times. The fertilizer may be applied in either dry or liquid form at specific intervals, or it may be applied with an injector system in diluted form each time the plants are watered.

When the fertilizer is applied dry, the amount to apply will depend upon the analysis of the fertilizer, but a rule of thumb used in applying a complete fertilizer in dry form is one level teaspoonful for each gallon of container. This is applied each month of the growing season. A maximum of six applications should be made. If the containers are "pot tight," the fertilizer may be applied broadcast at the rate of 12 pounds per 300 sq. ft. The media should be moist at the time the fertilizer is applied, and the plant should be watered after the application.

The analysis of the soluble fertilizer to be applied through an injector system will determine the rate and interval of application. A 20-20-20 analysis soluble fertilizer is usually applied at the rate of ½ ounce per gallon of water at two-week intervals.

The best method of determining rate of fertilization is the grower's observation of his plants. During periods of rapid growth, leaf size and color indicate whether an increased rate of fertility is needed.

8. Pruning and Supporting Container Plants

Container plants are pruned to give them the desired shape and to induce growth. Plants such as junipers, taxus, and most trees are allowed to develop a central leader. Proper pruning requires a knowledge of the growth characteristics of the plant.

Plants grown without a main trunk are normally pruned at the time they are planted in the container. Each spring the longer shoots are cut back to about one-half of their original length before new growth starts. To more evenly distribute the work load, pruning can be done in the fall.

Vines, groundcover, and plants having a compacted growth habit are not pruned.

Supporting Plants

Certain plants should be staked to support them in an upright position. Wooden or bamboo stakes two to three feet long are used for this purpose.

9. Harvesting Container Plants

Container grown plants are ready for marketing when they reach the size demanded by the market on which they will be sold. All of the plants should be labeled. It is also a good idea to attach a label which gives the cultural practices used for growing the plant.

Plants that cannot be held for another growing season in the original container should be sold. The root system of plants grown for too long in a container will develop into a spiral inside of the container. New roots will develop slowly, if at all.

LABORATORY EXERCISE

Activity: Planting container grown plants

Materials:

Plants
Media
Containers
Hose for watering plants

Procedure:

1. The container is filled to within 3/4 to 1/2 inch of the top with media.

2. The plant is planted in the center of the can, and the media is firmed around the plant roots.
3. The plant is watered.

REFERENCES:

1. "Nursery Production," Vol. 12, No. 4s, College of Agriculture, Pennsylvania State College, University Park, PA.

2. Stanley B. Moore, Ornamental Horticulture as a Vocation, Munkers Publishing Company, Fairborn, OH.

PRODUCING CONTAINER GROWN PLANTS

ADVANTAGES

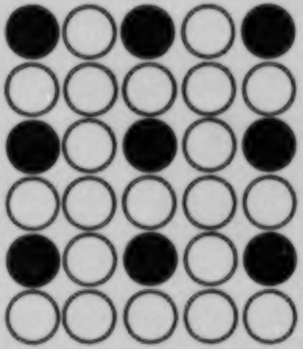
More plants may be grown in a given area
Plants easier to handle
Media used in containers is lighter than soil
Planting season longer
Less labor required
Some plants are easier to grow in containers
Plants sold when most attractive
Plants harvested easier
Growing conditions easy to control
Fewer plants lost from transplanting
Container plants better suited for marketing

DISADVANTAGES

Large quantity of media needed
Special equipment required to water and fertilize
No standards or grades

SPACING OF CONTAINERS

EXAMPLE No. 1

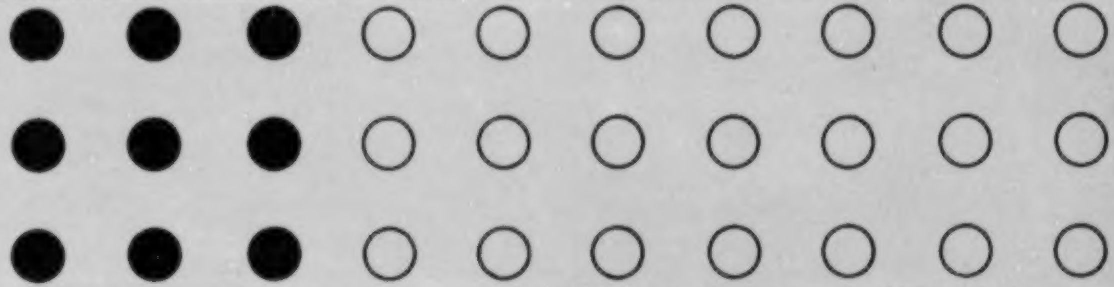


30 PLANTS

FIRST YEAR 'CONTAINER TIGHT'

(BLACK DOTS INDICATE PLANTS NOT TO BE MOVED THE SECOND YEAR)

EXAMPLE No. 2



9 PLANTS NOT MOVED

21 PLANTS SPACED CONTAINER DIAMETER APART THE SECOND YEAR

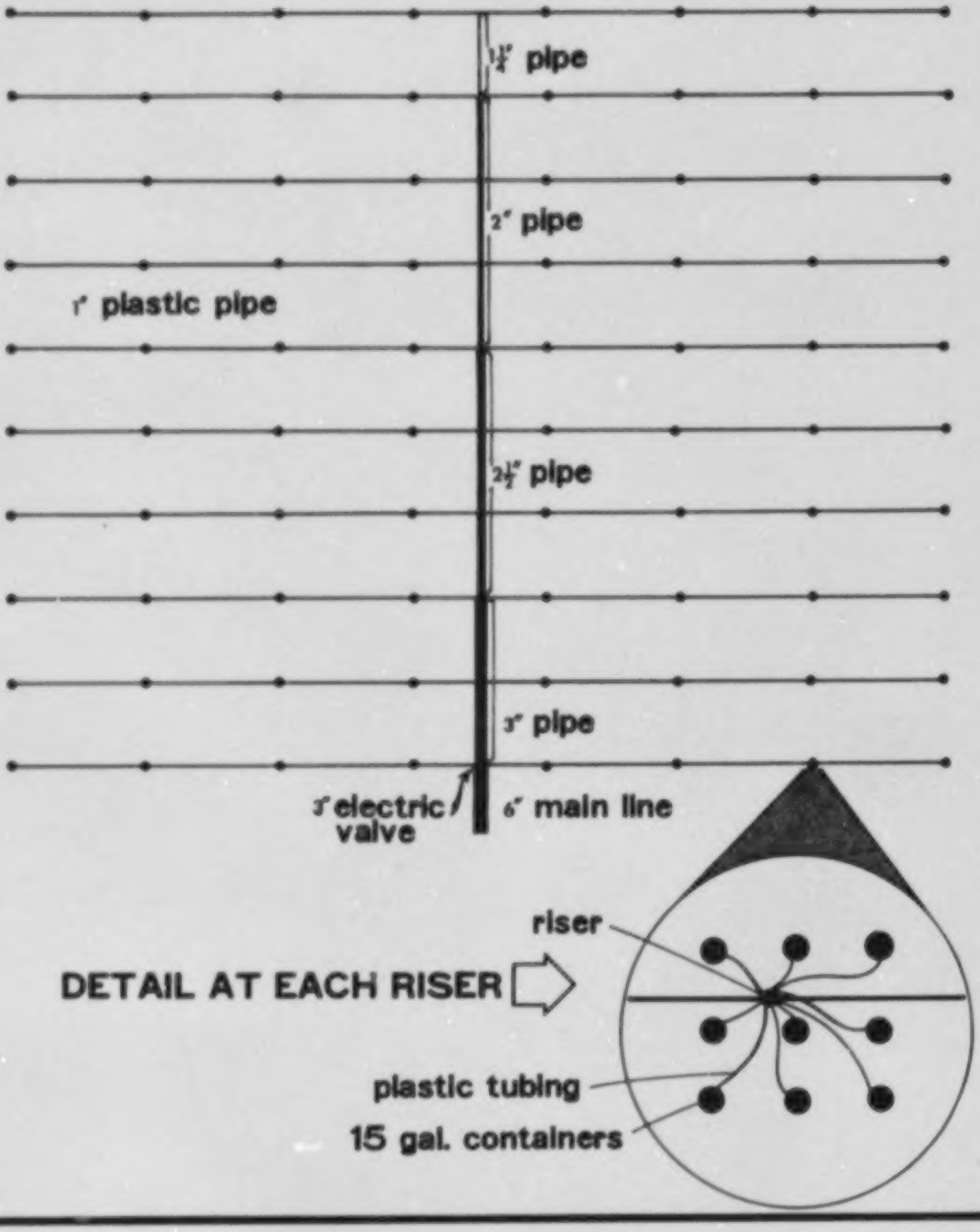
CROP PLAN FACTORS

- Planting schedule
- Number and sizes of containers
- Quantity of media
- Irrigation system
- Fertilizer injector system
- Work time required
- Building space, equipment, and tools
- Production and layout

FACTORS AFFECTING THE FREQUENCY OF WATERING

- ▶ **Growing Media**
    - ▶ **Size of Containers**
- ▶ **Materials From Which the Containers Were Constructed**
    - ▶ **Size of Plants**
- ▶ **Kinds of Plants**
    - ▶ **Season of the Year**
- ▶ **Weather Conditions**

SEMI-AUTOMATIC WATERING SYSTEMS


1½" pipe
2" pipe
1" plastic pipe
2½" pipe
3" pipe
3" electric valve
6" main line
riser
DETAIL AT EACH RISER
plastic tubing
15 gal. containers

Vocational Instructional Services
Agricultural Education

I-1
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit I: Developing and Maintaining the Landscape

Topic 1: Landscape Planning

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

A number of plants that are adapted to the different climatic regions of Texas are listed at the end of the topic.

Topics I-1 and 2 should be covered with the class in a sequence.

1. The Value of Landscaping

Landscaping is the art of arranging and the fitting together of land, plants, and buildings for human use and enjoyment. The public's opinion of a residential area largely depends upon the landscaping of the homes in the area. An area with attractively landscaped homes is usually considered to be a good area in which to live. An area in which the homes are not landscaped often creates an unfavorable impression and is not considered when a family is looking for a home to purchase.

A properly landscaped home is more valuable and easier to sell. Buyers realize the value of an established landscape and are aware that they will enjoy the landscape immediately rather than having to wait until it becomes established. The value increases annually as the plants grow to maturity.

Landscaping also offers benefits other than value and beauty. Certain types of plants help in reducing wind and noise pollution. They can reduce heat intensity and provide privacy for outdoor activities.

2. Selecting Plant Materials

Landscape materials refer to the materials such as plants, stones, concrete, gravel, and person-made items used in landscaping. Plant materials refer to the plants used in a landscape.

A knowledge of a large number of plants and their characteristics is required to properly develop a landscape plan. Also, a number of factors must be considered in selecting plant materials. Several factors that should be considered are listed and discussed briefly. They are presented in the order in which they should be considered.

Transparency No. 1

1. Shape and structural form-Growth habit affects plant form. Most plants have either vertical, horizontal, or rounded growth habits. The plants having different growth

habits have specific uses in the landscape:

a. Plants having vertical growth habits are used for framing, shading, screening, windbreaks, and steep plantings. Both vertical and rounded growing plants are used to contrast horizontal lines.
b. Plants with horizontal growth habits are used to complement horizontal lines.
c. Rounded growing plants are used for planting close to buildings, borders, plant screens, hedges, and specimen planting.

The growth of some plants can be made to produce a form that may be used in a number of places.

2. Plant masses-This refers to the grouping of plants. Plants are grouped to form a pleasing effect. Planting of three to six plants will often produce a more pleasing effect. Usually no less than three plants should be planted in a grouping.
3. Plant size-Mature size of the plant should be considered. The landscaper must visualize the size and appearance of the plant in five to ten years. This will affect the location of plants.
4. Flowering, fruiting, and other characteristics-Varying the color, form, size, and texture of plant materials in the landscape increases the variety and enhances the beauty. One method of creating interest is to plant plants having purple leaves among plants having a mid-green color. Another method is to plant pyramidal plants among predominantly rounded plants.
5. Evergreen and deciduous plants-Using a combination of both in a landscape increases interest and adds distinction. Evergreens are used as hedges, bed plantings, screening, and specimen plantings. Ground covers are usually evergreen plants and are used in problem areas of the landscape to tie groups of shrubs together, to provide cover under trees and other shaded areas, and to provide for steep banks and rocky areas. Both evergreen and deciduous trees may be used for framing, shading, screening, and windbreaks. Espaliers are trees, shrubs, or vines fastened to person-made structures (walls, fences, etc.) and trained in a formal pattern. They are usually evergreen.
6. Climatic region-Plants should be adapted to the region in which they will be planted.

3. Symbols Used in Making Landscape Plans

In order to read a landscape plan, the landscaper must be familiar with landscape symbols. Symbols (small pictures) and words are used to indicate plants and other information on the plan. Symbols are not standardized, but the more common ones are shown in the following transparencies. Others may be used.

Transparencies Nos, 2A and 2B

An explanation of each of the symbols is as follows:

Orientation-Three different symbols are generally used to indicate the direction of north on the plan. North on most plans is at the top of the sheet.

Scale-The scale should be noted on the plan and is used to indicate distance. Several factors will influence the scale to use. A scale of 1/8" = 1'-0" means that 1/8 inch on the plan is equal to one foot on the ground.

Construction Symbols-These symbols are used to designate walls, doors, and windows.

Paving-Four types of paving are illustrated. The different types of paving are labeled in the illustration, but this should not be necessary on the plan.

Boundaries-Either broken or solid lines may be used for boundaries; however, only one should be used on a plan.

Steps-Steps are indicated with a series of lines with an arrow indicating up or down.

Curved Walks or Drives-These are drawn on the plan according to scale, and the radius of the curve is given if the curve is made into a circle. The outside radius in the illustration would be 30 feet if the driveway is maintained at the same width.

Contour Lines-These are used to determine areas having the same elevation and is necessary for determining amount of excavation and fill.

Distance-It is indicated by either a dotted line or a solid line with arrows on each end. The distance is usually shown below the line.

Utilities-Dotted lines are used to represent wires and pipes, and a single dot is the symbol used for a utility pole. The first letter of the utility ("T" for telephone) is used to designate the type of utility, and the letters T P are used to designate the pole.

Fence-This symbol is used to indicate vine growing on a fence, vines growing on an arbor (pergola), and vines growing on a garden wall.

Plants-A number of different symbols are used to designate the plants in a landscape plan. A number of plant symbols are shown in the illustration.

Special Garden Features-A pool and grill are two of the special features found in the landscape plan. Other symbols may be used for other features.

4. Plant Spacing and Arrangements

A number of factors must be considered in the spacing of plants. Location, appearance, and effect (immediate as well as in the future), kinds of plants being used, and mature size of plants are a few of the factors to consider. General spacing recommendations are as follows:

Vines-on wall, fence, or arbor-10-15 feet apart
Ground cover-one foot high or less, trailing or creeping, sometimes forming neat compact mats, (a) slow growers like Euonymus radicans, 1 foot apart, (b) rapid growers like Lonicera japonica chinensis.
Vinca major-3 feet apart

Dwarf shrubs- 1-3 feet high-3 feet apart	Unless spreading
Small shrubs-3 to 5 feet high-4 feet apart	dimension is greater
Medium shrubs-6-9 feet high-6 feet apart	than upright growth

Large shrubs or small trees-10-25 feet high-8-12 feet apart
Standard trees-30-100 feet high-in a dense group or in screen or windbreak plantings-12 feet apart. Plants should alternate in two or more rows. The rows should be 6 feet apart, and the plants should be spaced 12 feet in the row; in normal woodland or grove planting the spacing should be 25 feet apart.

Transparency No. 3

Street Trees-On narrow streets (50-75 feet between buildings), narrow trees should be used, spaced 40 feet apart and "staggered;" i. e., alternating. The tree spacing on trees with medium width (75-100 feet between buildings) should be 40 feet apart, and medium size trees should be used. On wide streets (over 100 feet between buildings), large trees may be planted and spaced 50-60 feet apart; if possible, they should be set uniformly 6 feet inside the property line.

Hedge Plantings-A hedge should be broader at the bottom than at the top in order to prevent the plant from flying out at the bottom. Dwarf box edging and similar plantings should be allowed a space 6 inches in width planted 3-4 inches apart in either single or double rows. If double rows are used, the plants should be spaced 3-4 inches in the row, and the rows should be 3 inches apart. Low hedges (3-4 feet high) are usually allowed 2-3 feet in width, and plants are spaced 16 inches in the row. Tall hedges (6-8 feet high) are allowed 4-6 feet in width (10 feet in case of Arborvitae), and the plants are spaced 3 feet apart. Screen planting and windbreaks (30 feet high or more) are allowed at least 20 feet in width, except in case of a crowded single row of Lombardy Poplars which will require 10 feet. Standard trees are spaced 6-12 feet apart, depending on the size of stock at planting. If stock is small (3-4 feet), plants are set 6 feet apart in rows, and the rows should be 6 feet apart. After the trees begin to grow, every other plant may be removed. This should space the trees 12 feet apart in rows, and the plants should be alternated between rows.

Planting for Immediate Effect-The landscaper should not plant plants thicker than normal with the intention of thinning the plants later. The plants should be spaced normally, and ground cover or mulch-composed of decomposed sawdust, cane pulp, straw, or other materials-should be used to prevent the plants from drying out until they are large enough to shade the ground.

Perennials-Large herbacious plants (3 feet and larger) should be spaced 18-24 inches apart, while medium herbaceous plants ($1\frac{1}{2}$ -3 feet) should be planted 12-18 inches apart. Small herbaceous plants (smaller then 1 foot tall) should be spaced 6-9 inches unless they are spreading plants; spreading plants should be spaced 12-18 inches apart.

Annual-The recommended spacing for annuals is the same as that for perennials.

Transparency No. 4

Several different planting arrangements may be used, and some are included in the above transparency. A discussion of each line is as follows:

Line 1-The individual plant is a specimen, but through its spacing it can also be used as a hedge, clump, fenestration, baffle, or tracery.
Line 2-This line illustrates how a series of pendulous plants can be used to form an arched canopy and a hedge.
Line 3-Illustrated in this line are ways of using columnar plants to make hedges and vertical and horizontal fenestrations.
Line 4-This line illustrates two methods in which round and oval plants may be used to make fenestrations.
Line 5-Examples of three methods that may be used in developing a tracery are illustrated.

5. Plant Forms Used in Sketching Landscapes

Transparency No. 5

The illustrations in the above transparency are included to assist the student in sketching the landscape. The height of the plant forms should be drawn to scale or to approximate scale in order for those viewing the sketch to receive the proper perspective. When plants are sketched on the landscape plan and only the top view of the plant is shown, the diameter of the plant should also be drawn to scale.

Transparency No. 6

In order for the person making the planting to plant the proper plantings, the planting plan must be accurate and drawn to scale. In addition to the plan, detailed, written specifications should be prepared to supplement the plan. Any details omitted in the plan should be included in the specifications.

A list should be prepared of the plants in the plan.

A procedure that may be used to develop the plans and prepare the specifications is given below:

1. A plan similar to the example in the above transparency should be prepared;
2. Trees and hedges should be drawn on the plan to scale. The trees and hedges in the transparency above are drawn to an approximate scale of 1" = 18'. However, groundcover, shrubs, and flowers are sometimes drawn on an enlarged scale in order to project a better perspective. The scale for these plants in the above example is 1" =5'. Surrounding features and their location also should be designated on the plan.

3. The list of plants that will be used in the landscape plan should be prepared. The list should include the plant number, and the number should correspond to a designated number and plant on the plan. Scientific and common names should also be provided on the list for each plant. Also, a list should be compiled of the quantity of each plant that will be used in the landscape. Other factors to be included in the list are the size and condition of plants, ball diameter and depth to plant B & B plants, and the depth that bare-rooted plants should be planted.
4. A work sheet should be prepared. Some of the information to be included in the work sheet are location of the areas for planting beds; fence details; spacing distances of vines, ground covers, and flowers; size of trees; amount of seed, sod, or springs to be used in planting the lawn; and media mixture and amount that will be used in plantings.

6. Providing Drainage for Landscape Structures

Most home sites usually require some grading to provide satisfactory drainage. This must be considered by the landscaper when developing the landscape plan. Some general rules which may be helpful when providing drainage are as follows:

1. Water should never be directed so that it will damage adjoining property;
2. Water should be directed to storm sewers when possible;
3. The movement of soil is expensive and seldom does it improve the beauty of a site;
4. In many instances it is more desirable to extend a porch or terrace over a slope rather than move large amounts of soil (the blueprint, however, must include it);
5. Topsoil should be moved and piled separately if it is necessary to move large amounts of soil;
6. If the grade is lowered around trees or shrubs, a light mulch of peat moss is used to cover exposed roots. (This prevents damage to the tree or shrub); and
7. The maximum depth of the fill used around trees is one inch. Two inches of a gravelly soil may be used.

To determine the amount of soil that must be moved to level a site, the landscaper should run contour lines on the site. The desired level is determined and the vertical measurement at this level is noted. The differences in the elevations above this level are totaled to determine the amount of soil that will be moved. The mensuration table in the appendix may be helpful in determining the cost.

LABORATORY EXERCISE

Activity: Acquaint the student with architectural features and plant materials.

Materials:

Pencils
Ruler
Compass
Triangle
Drawing board

T-square

Procedure:

1. Attach a sheet of 8½"x11" white paper on the drawing board and lay out a ½ border all around the sheet.
2. Reproduce the landscape symbols shown in transparency numbers 2 and 3. A circle is used to represent a mature tree or shrub. Irregular lines may be drawn free hand.
3. Letter each symbol.

REFERENCES:

1. "Landscape Design, A Teacher's Manual," Pennsylvania State University, University Park, PA.

2. "A Planning Guide for Home Landscaping," Texas Extension Service, B-980.

3. "A Selected List of Woody Plants for Texas," Texas Experiment Station, MP-455.

CLIMATIC REGIONS OF TEXAS

Region I-East Texas

Includes most of cotton country in East Texas. Normally abundant rainfall (40 to 60 inches) except toward end of rather warm summer, when a long drought frequently occurs.

This region is normally favorable to the growth of woody plants.

Examples of More Desirable Trees

Deciduous Trees

Quercus phellos-Willow Oak
Quercus falcata-Southern Red Oak
Quercus lyrata-Overcup Oak
Liriodendron tulipifera-Tulip Tree
Platanus occidentalis-American Planetree
Nyssa sylvatica-Tupelo
Ginkgo biloba-Ginkgo
Ulmus alata-Winged Elm
Quercus laurifolia-Laurel Oak
Quercus macrocarpa-Mossycup Oak
Liquidambar styraciflua-Sweet Gum
Carya illinoensis-Pecan
Fraxinus americana-White Ash
Acer rubrum-Red Maple

Evergreen Trees

Quercus virginiana-Live Oak
Ilex opaca-American Holly
Pinus echinata-Shortleaf Pine
Cedrus deodara-Deodar Cedar
Magnolia grandiflora-Southern Magnolia
Pinus palustris-Longleaf Pine
Pinus taeda-Loblolly Pine
Juniperus virginiana-Eastern Redcedar

Ulmus americana-American Elm

Region II-Coastal Plain along Gulf of Mexico

Moderate summer temperatures with hot sunshine, short winters. Annual rainfall of about 30 to 40 inches. Borders on subtropical. Portions with swampy soils. High water table.

Examples of More Desirable Trees

Deciduous Trees

Quercus laurifolia-Laurel Oak
Quercus falcata-Southern Red Oak
Quercus phellos-Willow Oak
Platanus acerifolia-London Planetree
Platanus occidentalis-American Planetree
Carya illinoensis-Pecan
Celtis laevigata-Sugar Hackberry
Ulmus americana-American Elm
Liquidambar styraciflua-Sweet Gum
Acer rubrum-Red Maple
Ginkgo biloba-Ginkgo
Taxodium distichum-Baldcypress

Evergreen Trees

Quercus virginiana-Live Oak
Ilex opaca-American Holly
Magnolia grandiflora-Southern Magnolia
Pinus palustris-Longleaf Pine

Palms

Sabal palmetto-Cabbage Palmetto
Phoenix canariensis-Canary Datepalm
Washingtonia robusta-Mexican Washington Palm
Livistona chinensis-Chinese Fan Palm

Region III-Central Texas

Subhumid or transition region of Central Texas with black and chocolate colored soils. Moisture conditions intermediate between humid climate of East Texas and dry regions in Western Texas.

Examples of More Desirable Trees

Deciduous Trees

Carya illinoensis-Pecan
Ulmus parvifolia-Chinese Elm
Quercus macrocarpa-Mossycup Oak
Platanus acerifolia-London Planetree
Quercus phellos-Willow Oak
Quercus shumardi-Shumard Oak
Quercus muhlenbergi-Chinquapin
Brachychiton acerifolium-Flame Bottletree
Celtis laevigata-Sugar Hackberry
Ulmus crassifolia-Cedar Elm
Koelreuteria paniculata-Goldenrain Tree
Platanus occidentalis-American Planetree
Quercus falcata-Southern Red Oak
Quercus stellata-Post Oak
Fraxinus pennsylvanica lanceolata-Green Ash (Southern portion only)

Evergreen Trees

Quercus virginiana-Live Oak
Juniperus virginiana-Eastern Redcedar
Cedrus deodara-Deodar Cedar
Cupressus arizonica-Arizona Cypress

Quercus nigra-Water Oak

Region IV-Texas Plains

Rainfall varies from 12 to 22 inches. Warmer and drier than central regions.

Satisfactory Trees for All Parts

Celtis occidentalis-Hackberry
Ulmus parvifolia-Chinese Elm
Populus deltoides missouriensis-Southern Poplar
Robinia pseudoacacia-Black Locust
Fraxinus pennsylvanica lanceolata-Green Ash

Trees Likely to Succeed Over Most of Region

Platanus occidentalis-American Planetree
Fraxinus pennsylvanica-Red Ash
Populus alba silver-Silver Poplar

Less Desirable Trees That May Be Useful Under Especially Difficult Conditions in This Region

Acer negundo-Box Elder
Elaeagnus angustifolia-Russian Olive
Maclura pomifera-Osage Orange
Morus alba tartarica-Russian Mulberry

For Warmer Portions of the Region

Melia azedarach-Chinaberry
Broussonetia papyrifera-Paper Mulberry
Juniperus virginiana-Eastern Redcedar
Cupressus arizonica-Arizona Cypress
Melia azedarach umbraculiformis-Texas Umbrella Tree
Cedrus deodara-Deodar Cedar
Pinus banksiana-Jack Pine
Pinus ponderosa-Western Yellow Pine

Region V-Southwest Texas

Hot, dry climatic conditions. 12 to 22 inches of rainfall but excessive evaporation.

Most Promising Trees

Parkinsonia aculeata-Jerusalem Thorn
Phoenix canariensis-Canary Datepalm
Tamarix aphylla-Athel Tamarix
Populus deltoides-Eastern Poplar
Sabal palmetto-Cabbage Palmetto
Ulmus parvifolia-Chinese Elm
Washingtonia robusta-Mexican Washington Palm
Melia azedarach-Chinaberry
Sabal texensis-Texas Palmetto

Suitable Trees for Most Parts of Region

Gleditsia triacanthos-Honey Locust
Fraxinus pennsylvanica lanceolata-Green Ash
Morus alba-White Mulberry
Robinia pseudoacacia-Black Locust
Populus alba Silver-Silver Poplar
Broussonetia papyrifera-Paper Mulberry

For Difficult Areas

Maclura pomifera-Osaga Orange
Salix nigra-Black Willow
Acer negundo-Box Elder
Elaeagnus angustifolia-Russian Olive

Note: Native Mesquite is one of the most valuable roadside trees for this region but collected plants are difficult to transplant. When they can be saved near the road, this certainly should be done.

Region VI-Western Texas

Arid plateau conditions. Hot days in summer with occasional frosty nights. Cold winters and about 10 inches of rainfall annually.

Most Promising Deciduous Trees

Gleditsia triacanthos-Honey Locust
Fraxinus pennsylvanica lanceolata-Green Ash
Populus deltoides-Eastern Poplar
Robinia pseudoacacia-Black Locust
Chilopsis linearis- Desert Willow
Celtis occidentalis-Hackberry
Juglans notha- Notha Walnut

Less Desirable but Satisfactory Trees

Acer negundo-Box Elder
Melia azedarach-Chinaberry

Trees Suitable Under Irrigation or Along Irrigation Ditches

Ulmus parvifolis-Chinese Elm
Parkinsonia aculeata-Jerusalem Thorn
Sabal texensis-Texas Palmetto
Eucalyptus species

The information on the preceding pages pertaining to climatic regions of Texas was taken from Texas Extension Bulletin 980.

The following are common woody landscape plants recommended for the Southwest:

Scientific Name	Common Name
Abelia grandiflora	Glossy abelia
Acacia farnesiana	Sweet Acacia
Bambusa multiplex	Hedge Bamboo
Buxus harlandi	Harlands Box
Buxus microphylla japonica	Japanese Littleleaf Box
Cortaderia selloana	Selloa Pampasgrass

Scientific Name	Common Name
Cotoneaster pannosa	Silverleaf Cotoneaster
Elaeagnus pungens	Thorny Elaeagnus
Elaeagnus pungens Fruitland	Fruitland Thorny Elaeagnus
Euonymus fortunei vegetus	Bigleaf Wintercreeper
Euonymus japonicus	Evergreen Euonymus
Euonymus japonicus Boxleaf	Boxleaf Evergreen Euonymus
Fatshedera lizei	Fatshedera
Feijoa sellowiana	Feijoa
Gardenia jasminoides	Capejasmine
Gardenia radicans	Dwarf Capejasmine
Gardenia stricta nana	Intermediate Capejasmine
Heteropteris argentea	Redwings
Ilex altaclarensis Wilson	Wilson Altaclara Holly
Ilex cornuta	Chinese Holly
Ilex cornuta Burford	Burford Chinese Holly
Ilex cornuta rotunda	Dwarf Chinese Holly
Ilex vomitoria	Yaupon Holly
Ilex vomitoria Dwarf	Dwarf Yaupon Holly
Jasminum humile	Italian Jasmine
Jasminum humile revolutum	Upright Italian Jasmine
Jasminum mesnyi	Primrose Jasmine
Juniperus chinensis Pfitzerana	Pfitzer Juniper
Juniperus chinensis sargenti	Sargent Chinese Juniper
Juniperus horizontalis wiltoni	Bluerug Juniper
Largerstroemia indica	Crapemyrtle
Lantana camara	Common Lantana
Leucophyllum frutescens	Texas Silverleaf
Ligustrum japonicum	Japanese Privet
Ligustrum lucidum	Glossy Privet
Myrtus communis	True Myrtle
Nandina domestica	Nandina
Nerium oleander	Oleander
Photinia serrulata	Chinese Photinia
Pittosporum tobira	Tobira Pittosporum
Pittosporum variegatum	Variegated Pittosporum
Pleioblastus pygmaeus	Dwarf Bamboo
Plumbago capensis	Cape Plumbago
Podocarpus macrophyllus	Yew Podocarpus
Punica granatum Chico	Dwarf Pomegranate
Pyracantha coccinea	Scarlet Firethorn
Pyracantha crenata serrata Graber	Graber Firethorn
Pyracantha crenulata	Nepal Firethorn
Raphiolepis indica	India Raphiolepsis
Rosa banksiae lutea	Yellow Banks Rose

Scientific Name	Common Name
Sabal texana	Texas Palmetto
Salvia coccinea	Texas Sage
Santolina shamaecyparissus	Cypress Lavendarcotton
Sophora secundiflora	Mescalbean Sophora
Viburnum japonicum	Japanese Viburnum
Viburnum odoratissimum	Sweet Viburnum
Viburnum suspensum	Sandankwa Viburnum
Viburnum tinus	Laurestinus Viburnum
Xylosma senticosa	Shiny Xylosma

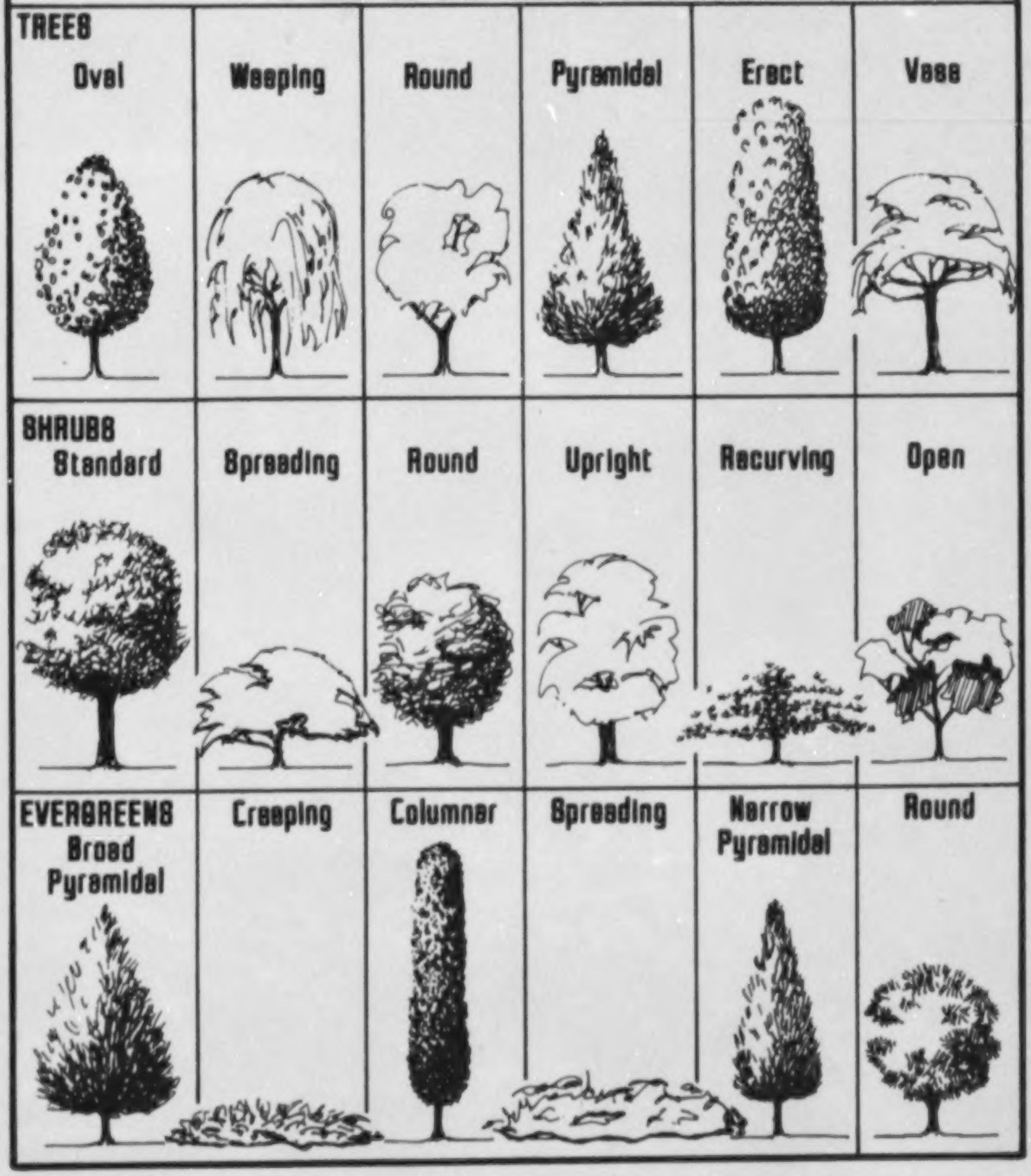
Vines

An ornamental vine is a woody plant which cannot support itself but must have a fence or trellis to climb on. Some vines used in Ornamental Horticulture are as follows:

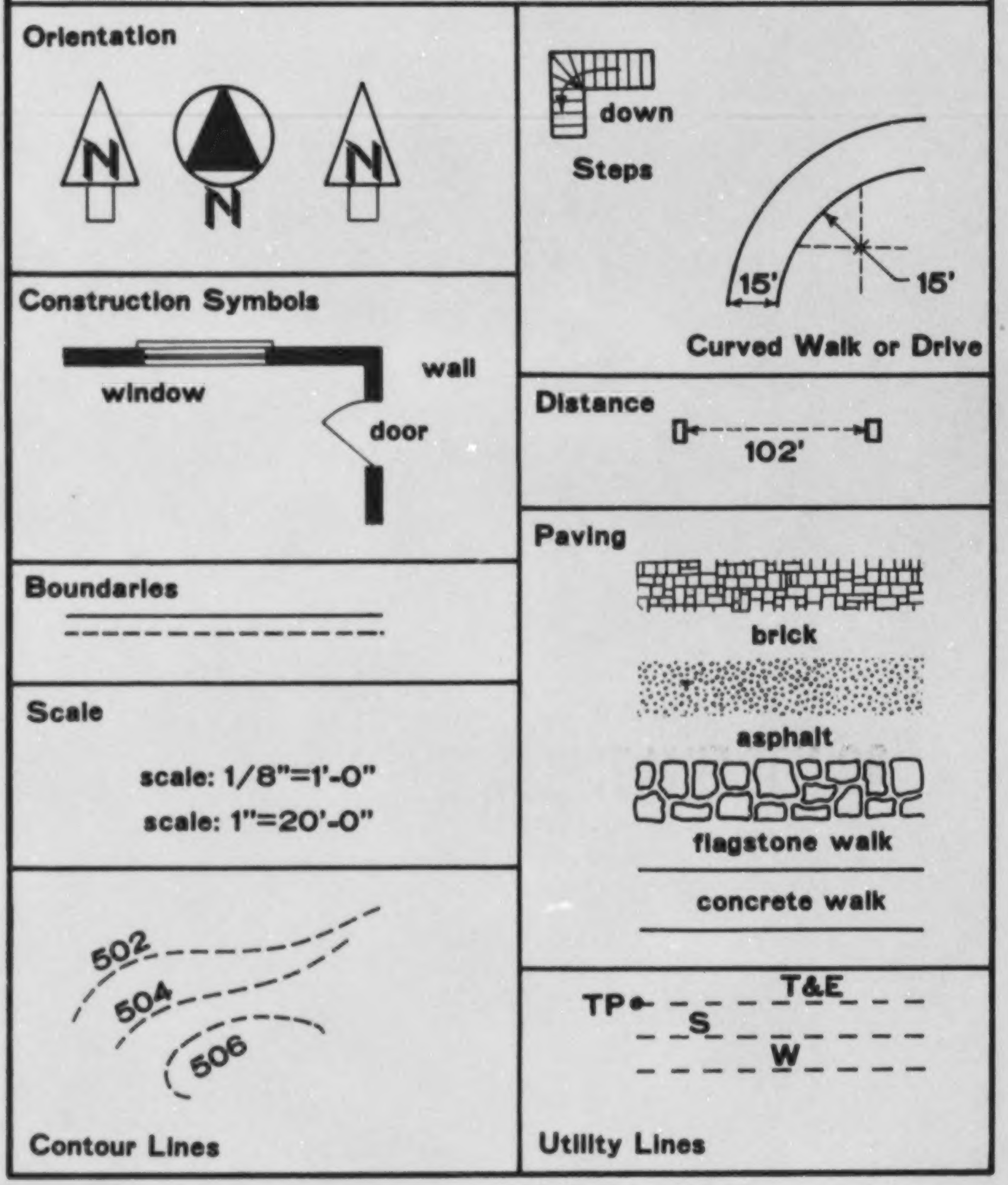
*Evergreen **Semi-evergreen ***Deciduous

Scientific Name	Common Name
**Ampelopsis arborea	Peppervine
**Bougainvillea (species)	Bougainvillea
***Campsis radicans	Common Trumpetcreeper
**Clematis paniculata	Sweet Autumn Clematic
**Clematis texensis	Scarlet Clematis
*Euonymus fortunei and varieties	Wintercreeper Euonymus
*Ficus pumila	Climbing Fig
*Gelsemium sempervirens	Carolina Jessamine
*Hedera canariensis	Algerian Ivy
*Hendera helix and varieties	English Ivy
**Lonicera heckrotti	Everblooming Honeysuckle
*Lonicera japonica chinensis	Purple Japanese Honeysuckle
*Lonicera japonica halliana	Hall's Japanese Honeysuckle
*Lonicera sempervirens	Trumpet Honeysuckle
***Parthenocissus quinquefolia	Virginia Creeper
*Passiflora caerulea	Bluecrown Passionflower
***Rosa (climbing varieties)	Climbing Roses
*Trachelospermum asiaticum	Japanese Star Jasmine
*Trachelospermum jasminoides	Chinese Star Jasmine
**Wistaria (species)	Wistaria

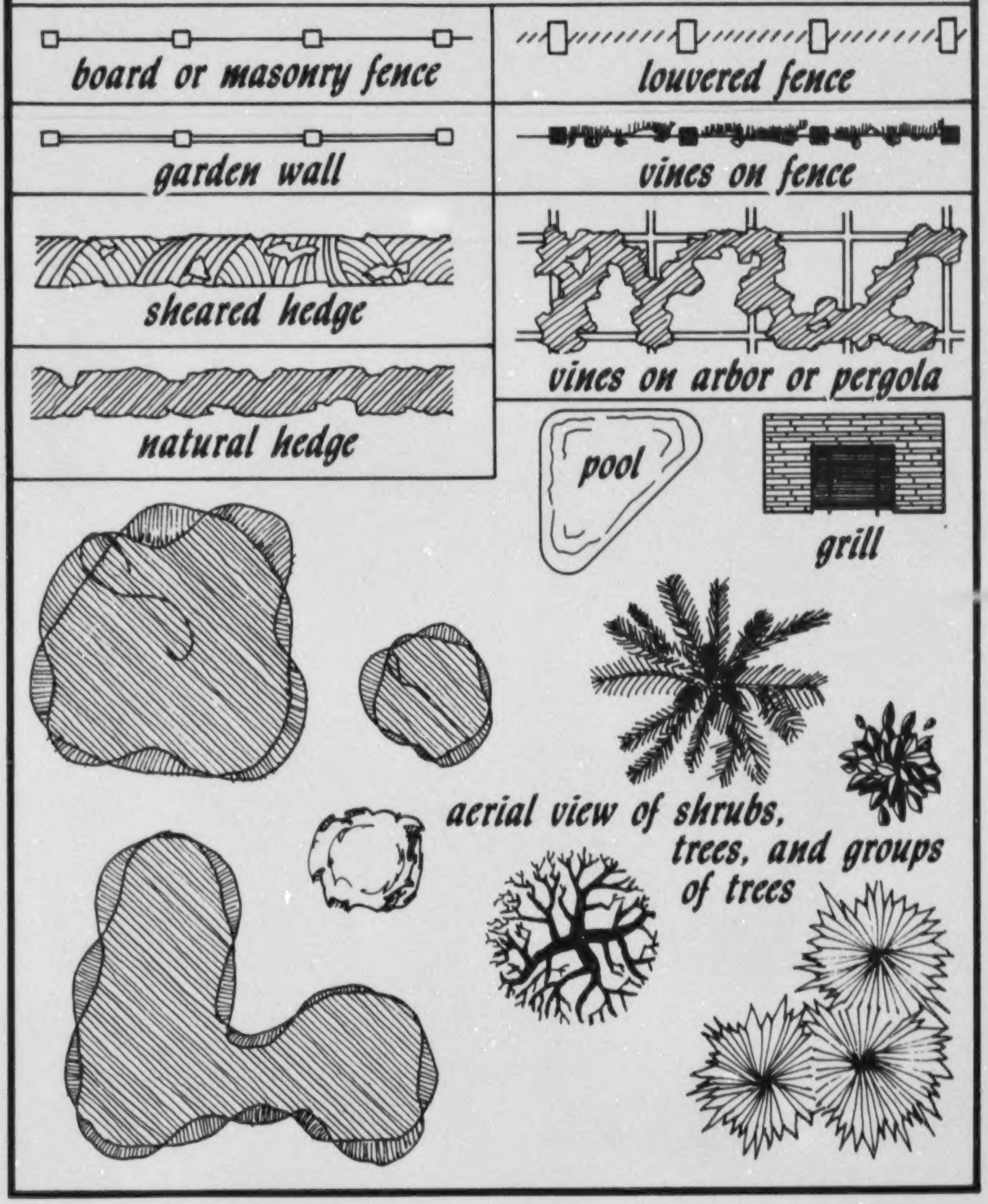
PLANT FORMS

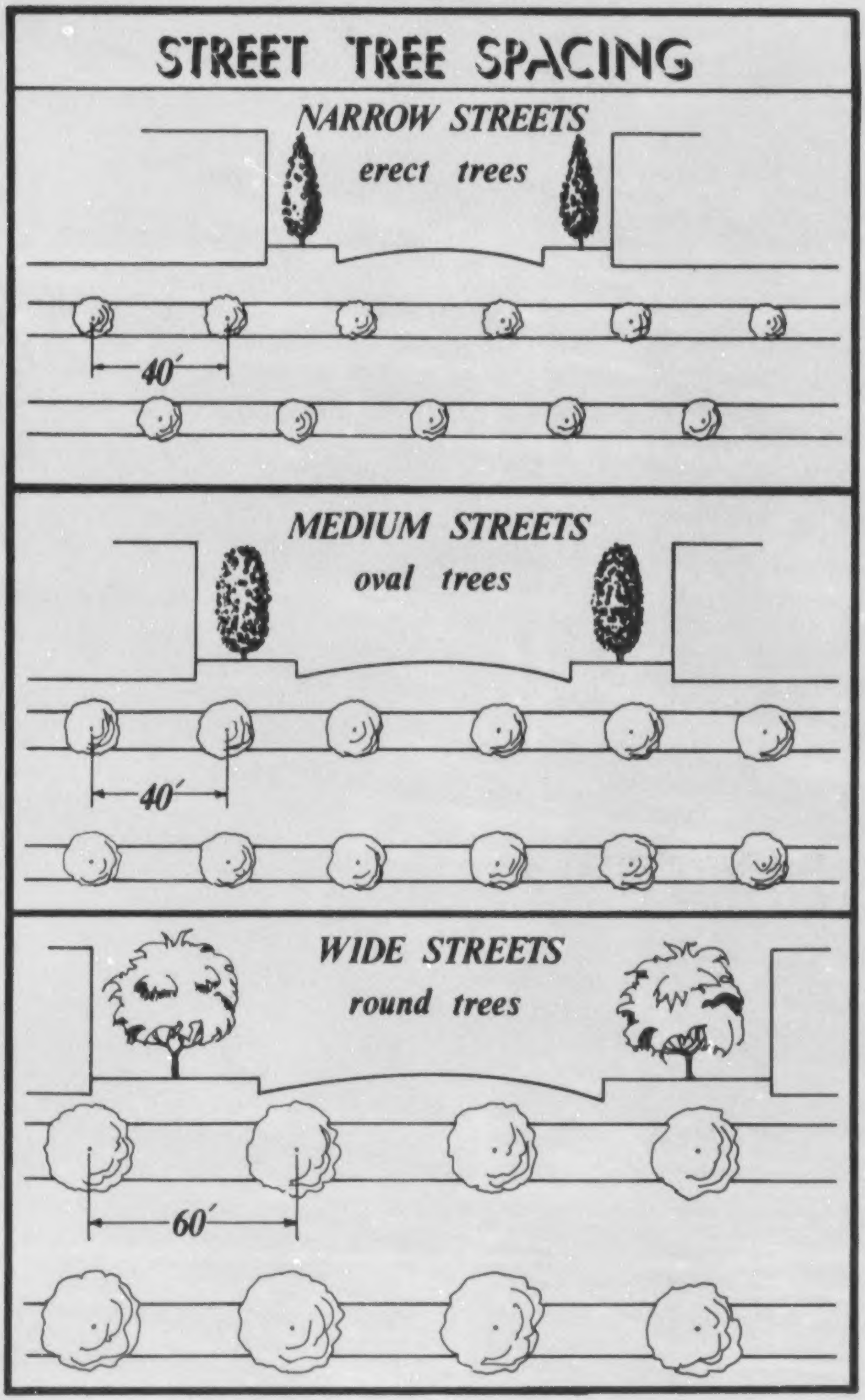

TREES
Oval
Weeping
Round
Pyramidal
Erect
Vase
SHRUBS
Standard
Spreading
Round
Upright
Recurving
Open
EVERGREENS
Broad Pyramidal
Creeping
Columnar
Spreading
Narrow Pyramidal
Round

LANDSCAPE SYMBOLS

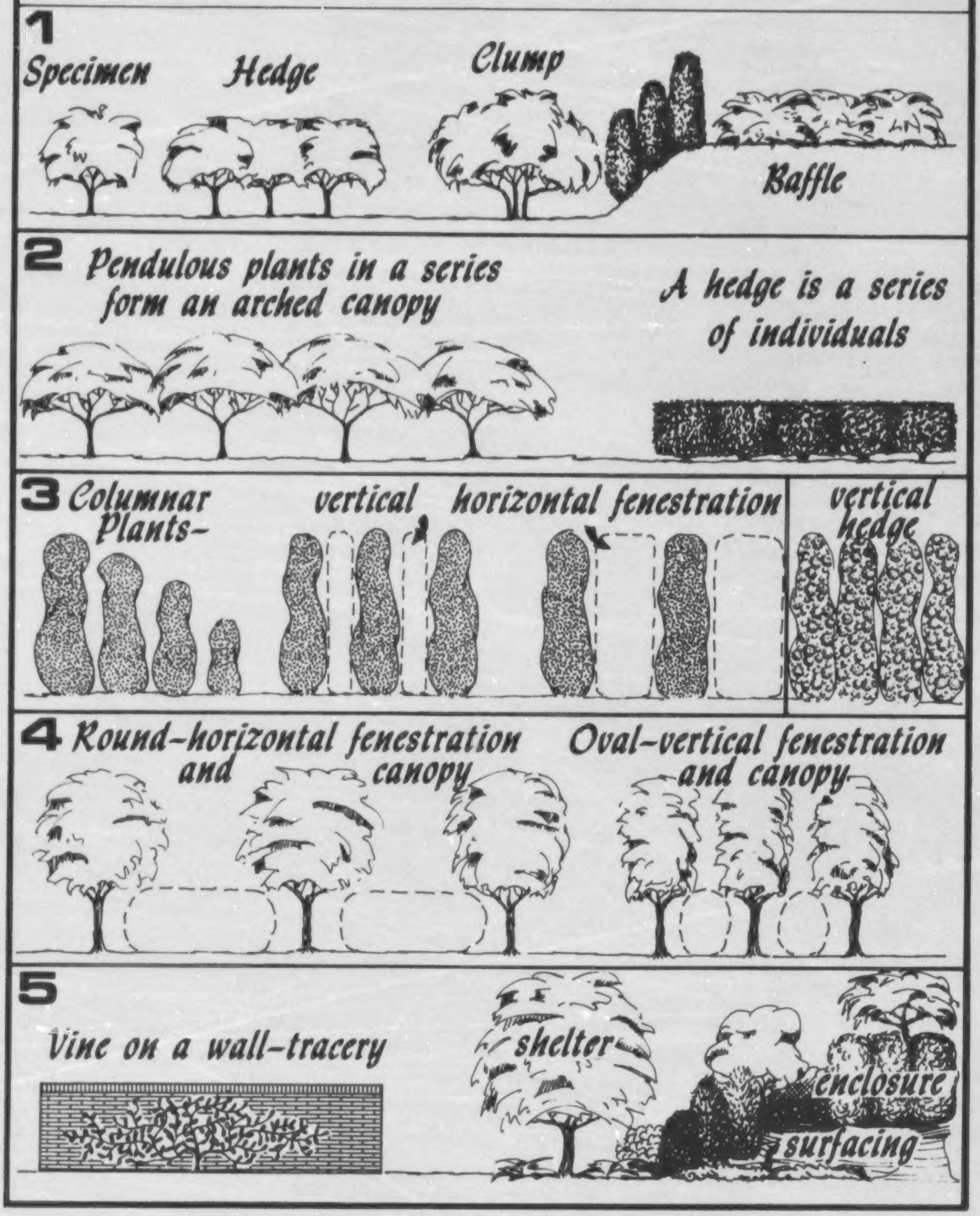

Orientation
N
N
N
down
Steps
15'
15'
Curved Walk or Drive
Construction Symbols
window
wall
door
Distance
102'
Boundaries
Paving
brick
asphalt
flagstone walk
concrete walk
Scale
scale: 1/8"=1'-0"
scale: 1"=20'-0"
502
504
506
Contour Lines
TP
T&E
S
W
Utility Lines

LANDSCAPE SYMBOLS

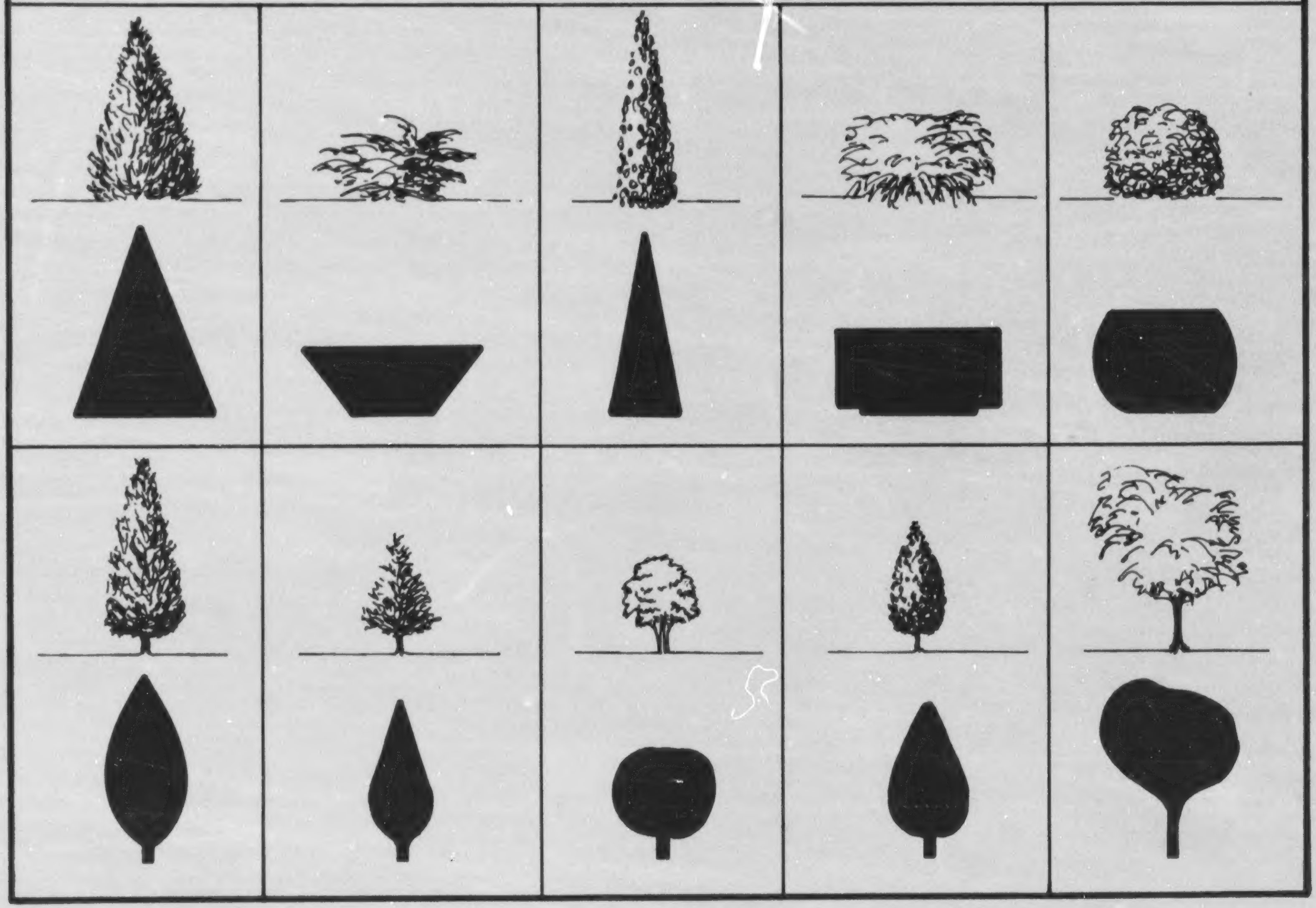

board or masonry fence
louvered fence
garden wall
vines on fence
sheared hedge
vines on arbor or pergola
natural hedge
pool
grill
aerial view of shrubs, trees, and groups of trees


STREET TREE SPACING
NARROW STREETS
erect trees
40′
MEDIUM STREETS
oval trees
40′
WIDE STREETS
round trees
60′

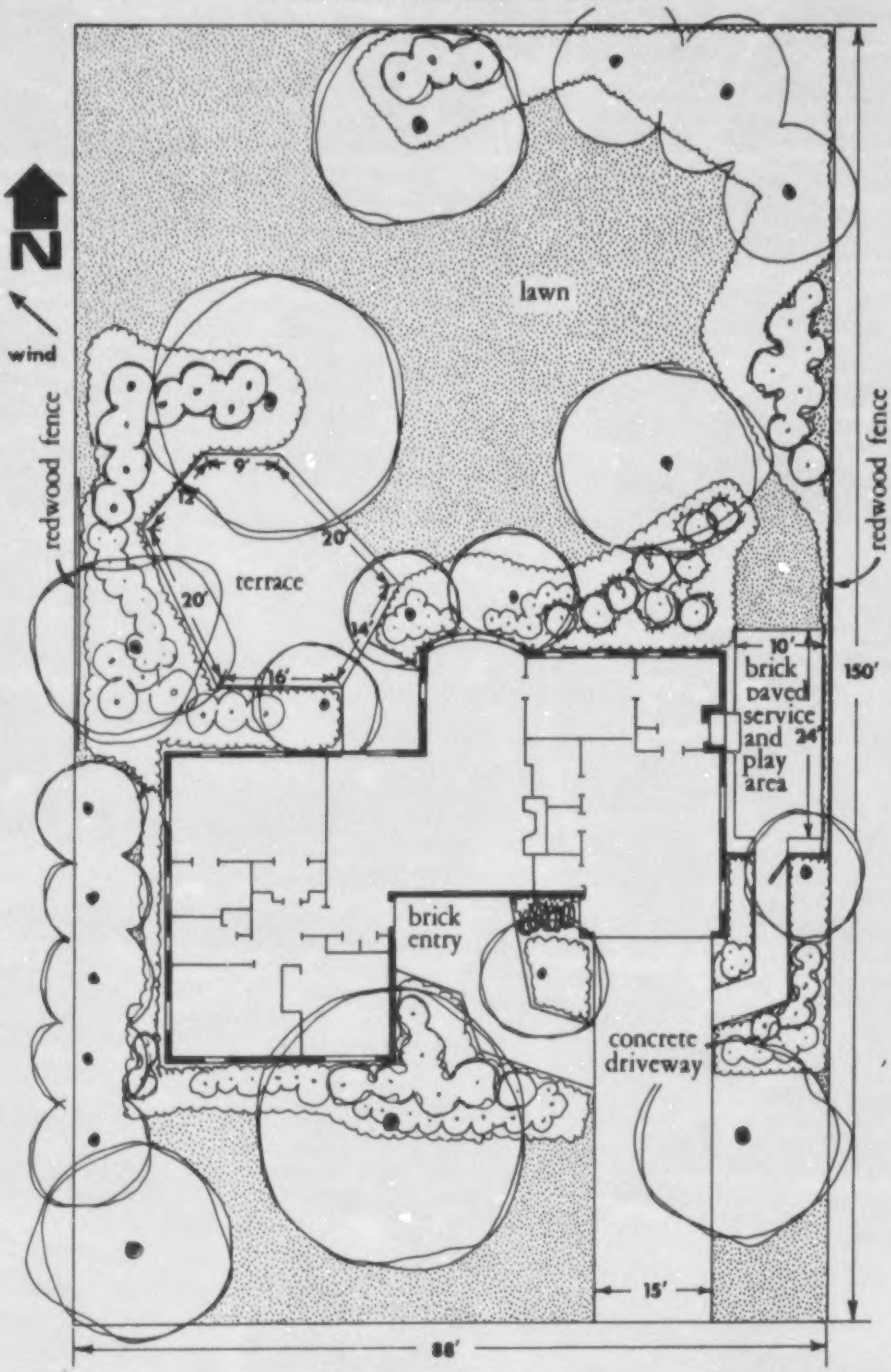
PLANTING ARRANGEMENTS


1
Specimen
Hedge
Clump
Baffle
2
Pendulous plants in a series form an arched canopy
A hedge is a series of individuals
3
Columnar Plants-
vertical
horizontal fenestration
vertical hedge
4
Round-horizontal fenestration and canopy
Oval-vertical fenestration and canopy
5
Vine on a wall-tracery
shelter
enclosure
surfacing

Typical Plant Forms & Corresponding Geometrical Outlines For Use In Sketching Landscapes



PLANTING PLAN


N
wind
redwood fence
lawn
redwood fence
9'
12'
20'
terrace
20'
14'
16'
10'
brick paved service and play area
24'
150'
brick entry
concrete driveway
15'
88'

Vocational Instructional Services
Agricultural Education

I-2
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit 1: Developing and Maintaining the Landscape

Topic 2: Preparing the Landscape Plan

Note: All terms underlined are included in the "Glossary of Terms."

1. Developing the Landscape Plan

A well-developed landscape plan prevents waste of labor, money, and planting materials. It also provides an orderly means of landscaping a site.

The size of a site has very little influence on the amount of time spent developing the plan. A small area or site is often more intensively used than a larger one.

An ideal situation is to develop the landscape plan before the building plans are completed. However, this is seldom done.

The first step in the development of a landscape plan is the site analysis. The site analysis is divided into two parts: (1) on-site analysis, and (2) off-site analysis.

On-Site Analysis

Chart No. 1

The on-site analysis is discussed first. A number of factors must be considered when making the on-site analysis. The above chart may be used in recording on-site features. It may be necessary to list information not shown on the chart when making this analysis. In order to get accurate information usually two people are required. Caution should be taken that all measurements and other information is accurate.

A discussion and explanation of some site features are given below.

Legal Aspects-Deed restrictions, easements, and building and zoning regulations need to be recorded. Boundary lines, right-of-ways, and setbacks should be drawn on the plan. Some cities have ordinances which prohibit the planting of plants within certain distances of curbs, the planting of certain plants, the construction of certain types and sizes of buildings, and the blocking of views.
Slope-The direction and percent of slope is needed in the development of the site. It may be necessary to run contour lines on a steep slope. Contour lines should be included in the plans.
Soil-A soil sample should be taken and a test of the soil conducted. Soil type, depth, fertility, structure, and drainage should be noted.
Rock Outcropping-The type, size, and location should be recorded. This area can often be developed into a spot of beauty.
Water-Springs, wet areas, overflows, and drainage should be located on plan.
Existing Vegetation-A record should be made of the size, shape, age, condition, and species of existing trees and shrubs.
Structures-Existing buildings, walks, fences, and other structures should be located on

the plan and listed on the site analysis sheets. Also, the exposure of the structure to the prevailing wind and their orientation to the sun should be noted. These two factors will influence the selection of plants.
Climate of Site-This is referred to as the microclimate and is the amount of sun, wind, and shade available to the different areas in the site. These factors will also influence plant selection.
Utilities-All utility lines (underground and overhead) should be plotted on the plan. This information will prevent the planting of trees where their branches and roots will interfere with pipes and electric lines.

While on the site, the landscaper should draw in site features such as trees and existing buildings, and the proposed building on graph paper. They may be placed in their exact location by taking two measurements from a boundary stake.

The procedure to follow in taking the measurements is shown in transparency No. 2.

Transparency No. 1

Only a limited number of site features are shown in the above example. However, all features relating to the site should be drawn on the graph paper.

Equipment needed to make the on-site analysis is listed below:

1. Drawing board
2. T-square
3. Architectural scale
4. Directional compass
5. Art gum eraser
6. Pencils
7. Graph paper
8. Metal tape, 100 ft.
9. Triangle, 30-60 degrees, 8 inch
10. Drawing set
11. Spring clip
12. Carpenter's string
13. Stakes
14. String level

Transparency No. 2

An easy method of establishing the location of a building on site is to take the measurements from two of the site corner pins each corner of the building. The exact location of the house corner "T" can be determined by measuring the distance from pin "A" and pin "D." The other corners are located in the same manner.

Off-Site Analysis

Two factors are considered in this step: (1) the view of the site taken from neighbors' property, and (2) the view of the site taken from greater distances. A mature oak tree located on adjoining property and within 10 feet of the site boundary becomes a part of the site landscape. A pleasant view of an adjoining backyard may be accented. Other favorable views include mountains, valleys, bodies of water, and towns and cities, especially at night.

Other considerations in the off-site analysis are pedestrian traffic, noise, dust, and bright lights. It may be necessary to screen unfavorable views such as utility lines, billboards, roads, schools, factories, junkyards, and unkept neighboring yards.

Analysis of Family Needs

The next step after an off-site evaluation is to analyze the needs of the family. Since the needs for each family are different, family members should be asked to list the facilities they would like for outdoor activities. After receiving suggestions from the family members, a list of basic plantings and structures such as walks, steps, drives, terraces, play areas, and turf is compiled.

The family size and ages of the family members will influence the landscape design. Parents with small children will want the facilities designed so that the children may use them. Sand boxes, swings, and slides are facilities that the family may wish to have constructed. Since the children will eventually grow up, these areas should be landscaped to allow for a different design in the future. Facilities that may be considered for larger children are a badminton court, croquet court, flower and vegetable plot, swimming pool, terrace, patio, benches, and planters.

Area Layout Plan

The next step is to plan the different areas in the landscape and to place these areas on the plan. The areas normally included in the plan are (1) public area, (2) service area, and (3) private area. Another area sometimes included is the play area. Each of the areas is discussed.

Transparency No. 3

The public area is generally the area in front of the house. However, it does not have to be at the front of the house. It could be on the side of the house if this is the approach the owner wishes visitors to use. This area can be drawn on the plan by placing a piece of tracing paper over the site analysis. A design is drawn on the tracing paper to indicate the approach.

The service area is the area in which trash cans, dog runs, clothes lines, and work areas are located. This area is often screened from view. This area also should be sketched on the tracing paper.

The private area is usually located at the rear of the house, but it may be on the side. Screening may be used to provide privacy in this area. This area is normally used by the family for outdoor entertainment and lawn games. The vegetable and flower garden might be located in this area.

After these three areas have been designated on the tracing paper, rough sketches of the organization of these areas should be drawn. Driveways, walks, clothes lines, and the recreational area should be included in the sketches. The landscapes should combine land used on the site when possible. For example, the lawn area and the area designated for badminton might be combined.

2. Principles Involved in Designing a Landscape Plan

The goal in developing a landscape plan is to design a plan that will achieve unity and harmony. The following nine principles should be considered in designing the plan:

1. Balance-The design should include a focal point or center of interest around which the landscape plants, structures, and open spaces are grouped or balanced. The plantings should be arranged in a sequence leading to or away from a focal point. The front entrance of the home is usually the focal point.

   A sense of balance is obtained by designating a real or imaginary point and by using mass, color, line, or texture in equal quantities on each side of the point. Either symmetrical or asymmetrical arrangements are used to obtain balance.

Transparency No. 4

Both the creation of a focal point and balance are illustrated. The landscaper can determine what must be done to make the front entry a focal point by drawing a sketch of the front of the house to scale on tracing paper. Then three points are made: one at the bottom center of the door and one at a point two-thirds of the distance up the right and left corners of the house. Dotted lines are drawn from the dots on the corners to the dot at the door. The planting of plants which will not extend above these lines will give a "V" pattern and direct the eye toward the door. Symmetrical balance is illustrated in picture "C"; pictures "A," "B," and "D" illustrate asymmetrical balance.

Symmetrical balance may be obtained in a formal garden by arranging duplicate plants on each side of an axis. Asymmetrical balance may be accomplished by using a contrast in shape and size of plants. The illustration shows a group of small plants used around the pool to obtain balance. Larger plants are used in a group to balance the large open area. A small area may be used to balance a larger area if the smaller unit contains greater attraction due to its color, texture, shape, or design.

Transparency No. 5

2. Simplicity-This is obtained by repeating the plantings. A few well-arranged forms, colors, or textures should be used. Simplicity is destroyed if too many different kinds of plants are used in a design.

Transparency No. 6

3. Proportion-Proportion refers to the size of units, such as open spaces, buildings, and plantings. A design is in proper proportion when there is a pleasing relationship between each part and the design as a whole.

A large shade tree, in order to maintain proportion, should be growing in a setting in scale with its size. Low-growing shade trees should be planted near a low, ranch style home. A tall tree should be planted near a tall, narrow house.

Transparency No. 7

4. Contrast-By using a contrast in size, texture, and color, harmony is achieved. For example, a low growing plant should be planted next to a tall growing plant, or a broad-leaf plant can be planted next to a narrow-leaf plant. A contrast of plant colors also may be used. A dark-green, evergreen plant offers a striking contrast against a white house. The shape of plantings can also be used as a contrast.
5. Repetition-There usually is a need for a reappearance of attractive materials in several locations in the landscape. Repetition can be obtained by repeating the exterior finishes, roof colors, similar plants, and other materials in several locations throughout the landscape.
6. Variety-A variety of plants and other landscape materials must be used to prevent monotonous repetition. Variety increases interest in the landscape.

Transparency No. 8

7. Sequence-An orderly, natural combination of landscape materials best describes the principle of sequence. Plants arranged in the proper sequence will usually have the lower growing plants planted in front of intermediate growing plants. Tall growing plants are placed behind the intermediate growing plants.

Transparency No. 9

8. Emphasis-Some houses have features that give a displeasing appearance. The above transparency shows a house that is too tall and methods of giving a tall house a pleasant appearance.

3. Grouping Plants

The first consideration is the selection of trees that will be used and included in the plant groups. Trees are used in a number of ways by landscapers:

1. Houses having dominant horizontal lines may be contrasted by the vertical lines of tree trunks;
2. Large, rounded trees are used to "tie" the house to the site;
3. The lines of a house can be softened with a canopy of tree branches growing over the house. This is accomplished by planting trees at an angle off of each corner of the house and between the house and the sidewalks; and
4. Trees are used for their shade. When planting trees for shade, they should be planted approximately 20 feet southwest of the area where the shade is desired.

The trees and the house should be in the proper perspective. Normally, small to medium height trees should be planted around one-story houses, while tall trees are planted around two-story houses. Low-growing trees can be used to screen the view in the public area. The plants are situated to prevent people from looking directly into picture and other types of windows. The plants are planted in the line of sight, but they should be planted several feet from the window. Large trees should be planted 40 to 60 feet apart, while the spacing of smaller trees is 10 to 20 feet.

A list of tall, medium height, and low growing trees and the areas of the state in which they are adapted is included in Topic I-1 of these materials. Also listed are a number of shrubs and vines.

After selecting the number and kinds of trees, the next step is to select and determine the placement of shrubs. Shrubs are of three sizes: (1) tall (8 to 10 feet), (2) medium (4 to 6 feet), and (3) short (2 to 4 feet). Also, shrubs are available in three forms: (1) upright, (2) rounded, and (3) spreading. Deciduous, needle-leaved, evergreens, and broad-leaved evergreens can usually be obtained in different sizes and forms.

Spacing of shrubs in the landscape is determined by their growth habits and their intended use. A spacing that will give a "chocked" appearance should be avoided. Shrubs should be spaced four to six feet from a house, wall or fence. The desired appearance in a landscape is obtained by the spacing, selecting, and arrangement of plantings. A formal planting is obtained by planting an equal number of plants on each side of a dominant landscape feature. Small, "heavy" looking plant groups are balanced by a larger amount of "lighter" looking materials in informal plantings.

Both deciduous and evergreen plants should be used in a planting. A good proportion is one-third evergreen plants and two-thirds deciduous plants. A planting containing all evergreens gives the appearance of being heavy in summer, while a planting composed entirely of deciduous materials appears thin and lacks interest during the winter.

The grouping of plants within a bed will determine the appearance of the bed. Tall trees and shrubs will have the appearance of being tied to the ground when spreading shrubs are planted under them. The taller plants should be planted to the back when grouping plants in a bed. Plantings consisting of more than one specie should have each specie planted in informal subgroups. An odd number of plants (three, five, seven, etc.) should be used. "Rhythm" can be obtained by repeating the planting of small groups of a specie within a bed, or the preparation of several beds adjacent to each other will create rhythm. This is also true when plants are grouped according to form, color, or texture.

A sharp contrast in the landscape is acquired by changing the texture or color of the plants used. A smooth blending is obtained by gradually changing the texture or color. Fine textures and subdued colors are better suited for small areas. A contrast is used to attract attention. Generally, there is a specific purpose for using a contrast in a landscape. Harmony, rhythm, and unity are usually the theme that should be followed.

The materials used along walks and entrances should be small as these areas are viewed from a close distance. This allows a person to examine the fine texture of branches, leaves, and color.

4. Lawn Areas

The lawn area contributes greatly to the landscape of the home. The two lawn areas are public and private areas. These two areas should not be destroyed by the planting of scattered plants and should provide space for outdoor recreation. The space requirements for some outdoor games are as follows: croquet, 30' x 60'; badminton, 24' x 54'; and volleyball, 40' x 70'. In a yard where space is at a premium, it may be desirable to develop a paved court yard with beds provided for shrubbery, trees, and bedding plants. The proportion of paved area to the rest of the yard will affect the appearance of the site. Too much pavement will not give the desired appearance.

A number of objects such as sculptures, birdbaths, fountains, pools, or specimen plants are used for decorating the public and private area. "Good taste" should be used in selecting ornamental objects.

The most difficult site to landscape is one that slopes uphill or away from the house. Structural and screening problems not usually encountered with level areas present a challenge in an area sloping uphill from the house. A site that is steeply sloped away from the house lends itself to terracing, rock gardens, and other creative uses.

Screening the Service Area

The service area should be screened from the public and private areas. The need for screening can be determined by viewing the service area from different locations. Both structures and plants may be used for screening. If an area for children to play is to be provided in the service area, it should be visible from the kitchen.

5. Planning Landscape Structures

Walks, drives, walls, fences, and terraces are the structures often used in landscaping. The structures have size, form, texture, and color. Their selection and design should provide unity and harmony in the landscape.

Transporting structures (drives, steps, and walks) are used to move to and from the house when turf and packed soils are not adequate for movement. Their size, location, and design will vary according to the needs of the family and site.

Walks

Walks should be wide enough (4 to 6 feet) to allow two people to walk abreast. If secondary walks are needed, they can be narrower (2½ to 3 feet). Convenience and attractiveness should be considered in placing walks. Primary walks should be hard surfaced, but secondary walks may be constructed of stones, concrete blocks, or hard surfacing materials. Stepping stones should be placed 26 to 28 inches apart and constructed of materials of a medium colored tone to prevent glare produced from light colors and heat produced from dark colors.

Driveways

Driveways are used to accommodate service and family vehicles. The garage location and the number of family vehicles will influence the location and design of driveways. A one-car driveway should be a minimum of 10 feet wide but 12 feet is more desirable. A minimum of 18 feet is required for the safe passing of cars. If a parking area is provided, the driveway may be narrower. A paved parking bay is usually more practical than a circular driveway and prevents the danger of having to back into a street. Circular driveways reduce the need for a wide driveway and masses of concrete. If a circular driveway is to be constructed, the landscaper should be aware that the outside wheels of a car in a tight turn trace a circle about 60 feet in diameter.

The driveway surface may be of loose aggregrate, asphalt, or concrete. Loose aggregate has a small initial cost but a higher maintenance cost. It also lacks durability.

Steps

Transparency No. 10

Steps are used when there is an abrupt change in the elevation of the site. The steps should be the same width as the walk. They should be designed for safety, convenience, and in harmony with the surroundings. Steps having a landing and a change in direction are more attractive and easier to use than long flights of steps. The width of the step is determined by the elevation of the slope but 14 inches is the minimum width that should be used. A one-inch overhang ("nosing") and a one-fourth-inch drop back to front will improve the design.

Retention Structures

Retention structures are used on steep slopes when erosion cannot be prevented by plants. The most common types of retention structures are masonry and dry walls. Dry walls are constructed of field stones or other materials. Mortar is not used in a dry wall. The stones in this type of wall should be large and heavy. The wall must be anchored to withstand pressure. Dry walls more than five feet high cannot withstand the pressure and will collapse.

Transparency No. 11

Water must be drained from behind a dry wall to prevent destruction of the wall. The base of the dry wall should be at least half as wide as its height, and the stones should slant slightly toward the rear.

Fences

A number of different kinds of fencing materials may be used. The fence design should be influenced by the needs of the landscape. Fences are used to permit privacy or a division of property before plants can provide the necessary screening. Walls are also used for the same purpose as fences, but they are more costly.

6. Developing the Completed Landscape Plan

At this point, the landscaper has acquired all of the information needed in order to complete the plan. The final step is the preparation of the landscape plan and the specifications.

Since most home owners prefer to review more than one plan, several alternate plans should be prepared. All of the plans should be complete, include all landscaping materials and structures, and be drawn to scale. Mature plants are shown on the plan, although smaller plants are most often used. For identification purposes, all the plants on the plan should be numbered. Plants of the same variety are designated by the same number.

The specification should include the following.

1. Variety of plants;
2. Grade of plants to be used;
3. Size of plants to be used;
4. Root system (B&B or bare rooted);
5. Amount of media, concrete, fencing, and other materials required to landscape the site;
6. Time required to complete landscape plan; and
7. Cost.

Laboratory Exercise No. 1

Activity:

Acquaint the student with orientation, scale, and sketching techniques for landscape horticulture (This exercise should help the student develop a better understanding of scale and orientation sketches.)

Materials:

Drawing board
T-square
Architectural scale
Pencils
Art gum eraser
Paper
Triangle, 30-60°, 8 inch
Compass

Procedure:

1. A border is drawn ½" from the edge of the paper around the sheet. The sheet is oriented so that north is toward the top of the sheet.

2. A scale of 1 inch equals 8 feet is used. Starting 4 feet from the left hand border and 4 feet from the top border, a 40 foot horizontal line is drawn from west to east. At 5 foot intervals from the first horizontal line, lines are drawn 36', 34', 31', 28', and 25½' long.
3. Starting at a point 14' from the end of the 40' line, a vertical line is drawn 34' long. Sixteen feet from the end of the 36' line a vertical line 30' long should be drawn toward the south. Fifteen feet from the 34' horizontal line, draw another vertical line 25' long toward the south. Twelve feet from the 31' horizontal line a 20' long vertical should be drawn toward the south. Another vertical line should be drawn 15' long toward the south 10' from the end of the 25½' horizontal line.
4. A rectangle should be drawn 25' long from east to west and 10' wide from north to south. The starting point should be 4' south of the west end of the 25¼' horizontal line.
5. A 20' square should be drawn. The starting point should be 5' from the south end of the vertical lines and parallel with the 9½' vertical line.
6. A circle with an 8' radius should be drawn. The center of the circle should be a point 12' east and [illegible] south of the southwest corner of the rectangle.
7. A circle with a 6' radius should be drawn. The center of the circle should be located at a point 8' east and 8' south of the square.
8. At a point 25' south of the southwest corner of the rectangle the following lines should be drawn. A vertical line 10' long should be drawn toward the south. A line 2' long should be drawn toward the east and labeled point A. A line 10' long should be drawn to the east. A line 2' long should be drawn toward the south and labeled point B. Points A and B should be connected with a concaved arc. The radius of the arc should be determined.
9. The following lines should be drawn at a point 4' south of the southwest corner of the square: a horizontal line 10' long to the west and a vertical line 10' long to the south.

Laboratory Exercise No. 2

Activity:

Prepare a site analysis

Materials:

Site analysis check-off list
Graph paper
Pencils
Equipment for drawing site features (listed elsewhere in topic)

Procedure:

1. The student should be assigned a home site to analyze. Students may work individually or in groups.
2. On-site and off-site analyses should be conducted.

3. Site features should be drawn on graph paper. All features relating to the landscaping of the site should be included.
4. After the site analysis has been completed, the teacher may with to have the class visit several sites and check the analysis.

Laboratory Exercise No. 3

Activity:
Prepare a landscape plan for a home site

Materials:
Site analysis check-off list
Graph paper
Pencils
Drawing equipment

Procedure:
1. The site analysis should be conducted. The student may use the same site analysis as was used in laboratory exercise no.1.
2. The landscape plan should include a blueprint or drawing showing the location of all buildings, location of all plants, location of landscape structures, specifications of plants, and a list of plants.

References:

1. "Landscape Design," Vol. 9, No. 3t, College of Agriculture, Pennsylvania State University, University Park, PA.

2. "Landscaping Your Home," Department of Agricultural Education, Ohio State University, Columbus, OH.

Much of the materials used in this topic was taken from the above listed references.

SITE ANALYSIS CHECK-OFF LIST

Location ____________ Lot No. ________ Date ________

Client's Name ____________________ Telephone No. ________

On Stie Factors

Lot: Dimensions: length ____________ width ____________

Rights-of-way: ________________________

Easements: ____________________ kind ____________

Legal restrictions: Setback distance ____________________

Lot lines ____________________

Corner obstruction ____________________

Fence: Setback dist. ____________ height ________

length ________ type ____________

Outbuilding ____________________

Trees to be removed: boxelder ____________

poplar ____________ willow ____________

others ____________________

Slope: percent ____________ direction ____________

Soil type: clay ________ loam ____________ sand ________

Drainage: good ________ fair ________ poor ________

Tile lines needed: ____________________

Soil Test Results: pH ______ N ______ P ______ K ______ Ca ______

Rock outcropping: size ______ location ________ type ________

Sidewalk: installed ______ not installed ______ never to be installed ______

Water: spring ______ brook ______ pond ______ marsh ________

I-2
Chart No. 1

Existing vegetation:	Trees ______	species ______	height ______	width ______
		______	______	______
		______	______	______
		______	______	______
	Shrubs ______	species ______	______	______
		______	______	______
		______	______	______
		______	______	______

Turf area ______________
satisfactory ______ renovate ______ replace ______
Bare soil ______________

Structures:
House ______ length ______ width ______
Front face north ______ east ______ south ______ west ______
other ______
Style ______________ color(s) ______
Material-brick ______ frame ______ stone ______ other ______
Outer buildings-length ______ width ______
Materials ______________
Driveway ______ width ______ length ______ material ______
Walks ______ width ______ length ______ material ______
Terraces ______ width ______ length ______ material ______

Climate:
Hardiness zone ______ on plan ______ prevailing wind direction ______ on plan ______
Orientation-north indicated on plan ______

Uitlities:
Overhead poles plotted ______
Underground water line ______
water valve ______
electric lines ______
drainage lines ______
septic tank ______ drainage field ______
dry wells ______
gas line ______
gas valve ______
gas meter ______

Off Site Factors

Favorable views

Kind ______	height ______	width ______	season ______
______	______	______	______
______	______	______	______
______	______	______	______

Pedestrian traffic: Control needed______________ not needed__________________

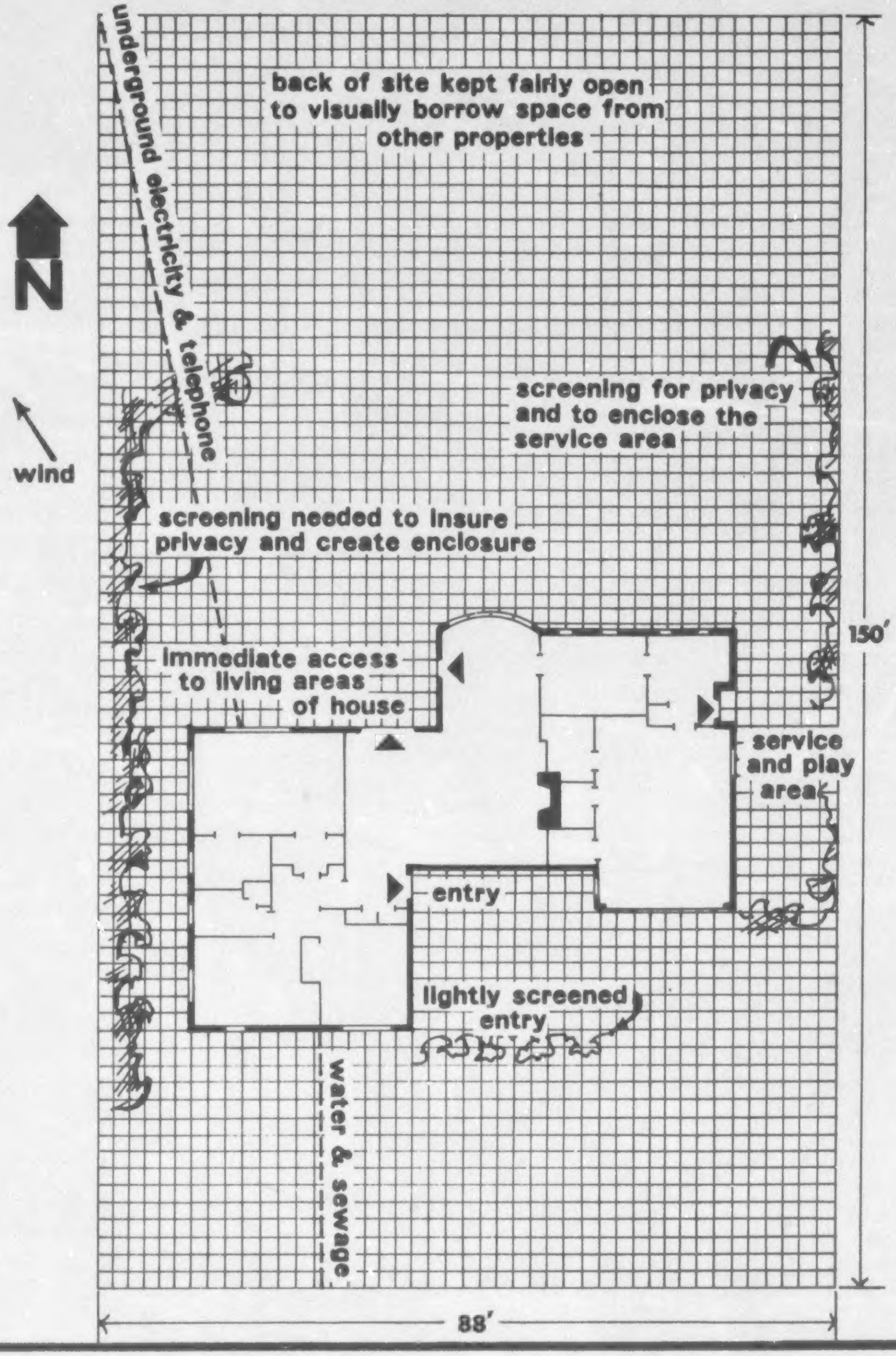
Noise: Control needed______________ not needed__________________

Dust: Control needed______________ not needed__________________

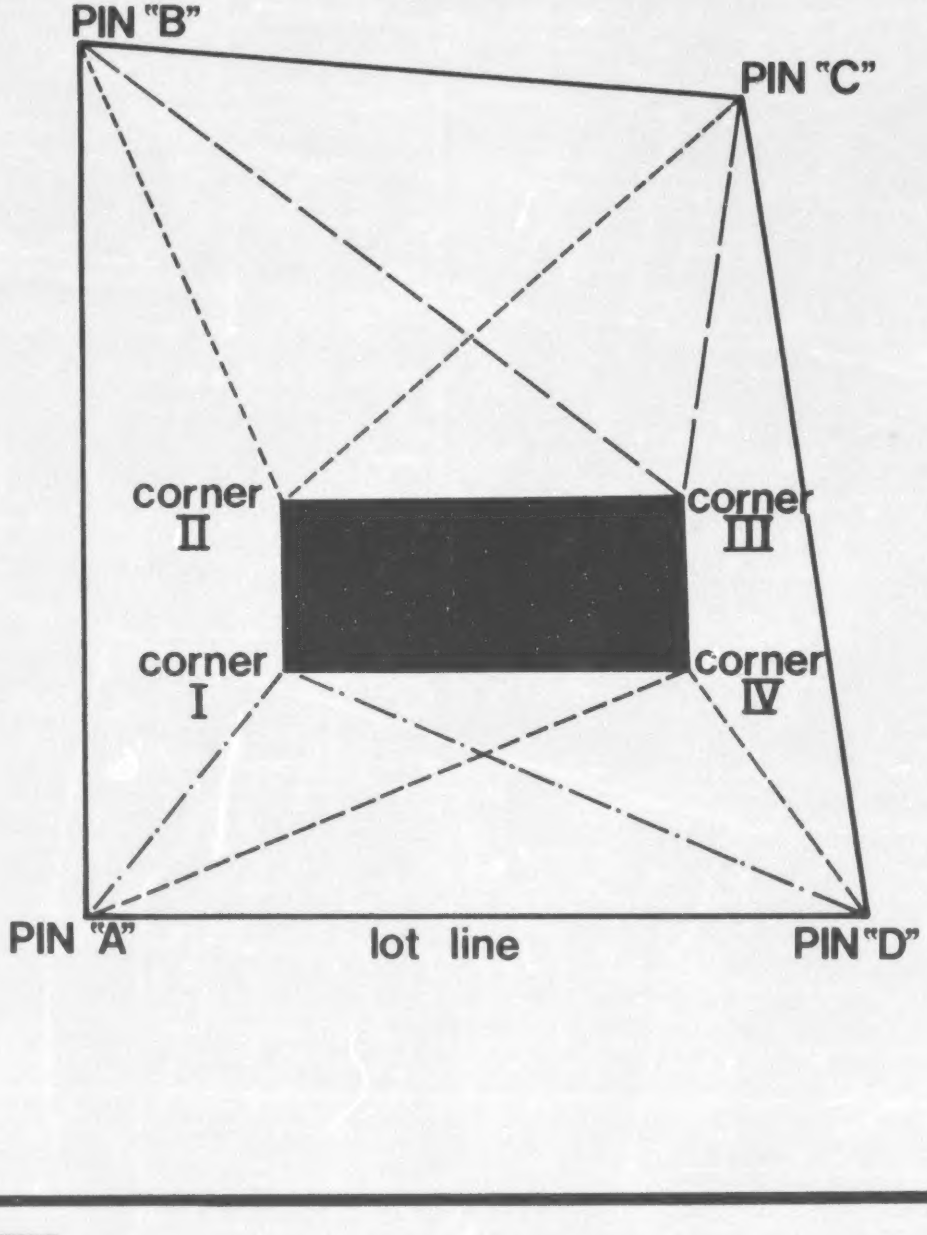
Bright lights: Car_________ parking__________ neighbor________ other_____

I-2
Chart No. 1
(Continued)

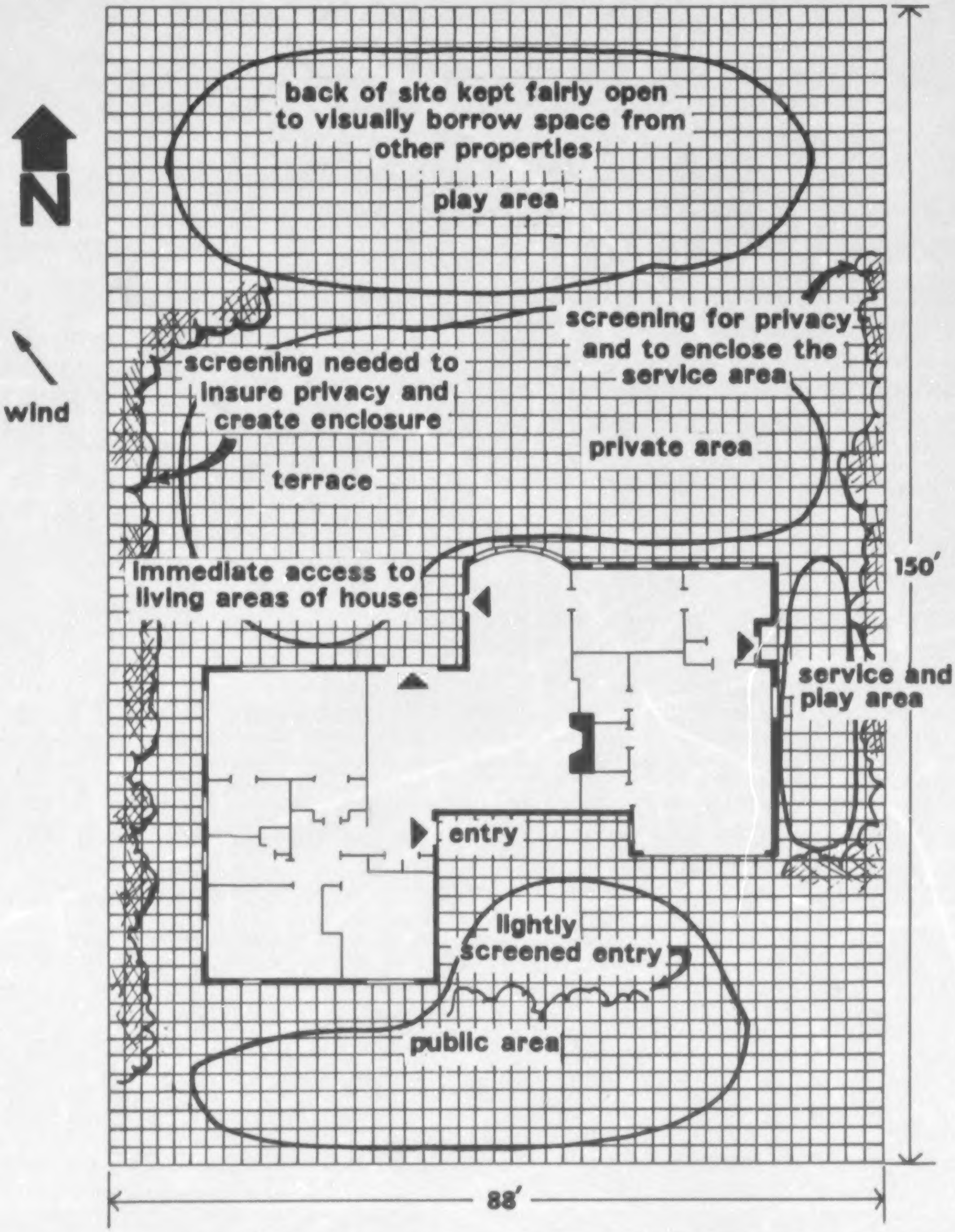
SITE ANALYSIS PLAN

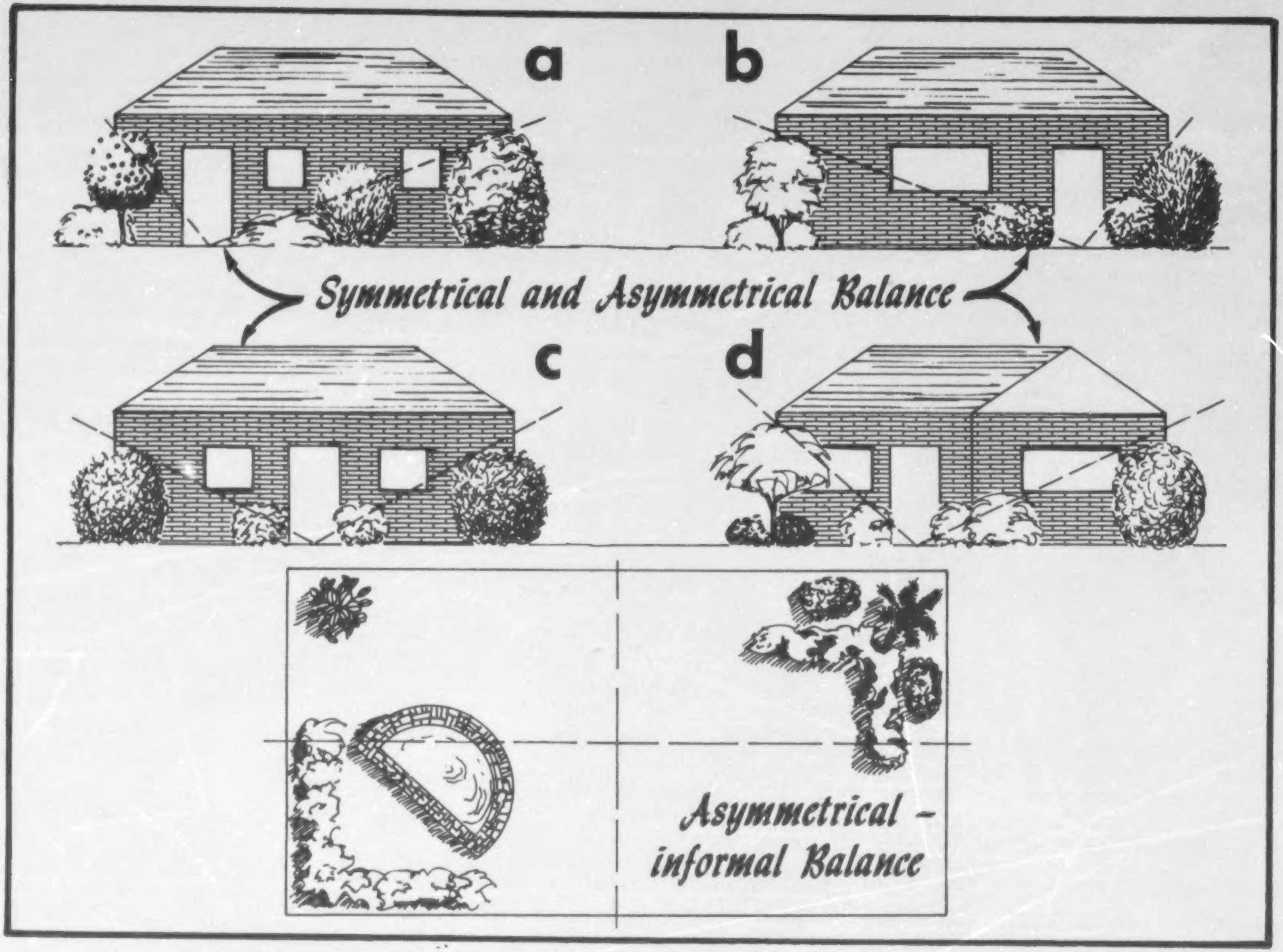

underground electricity & telephone
back of site kept fairly open to visually borrow space from other properties
N
wind
screening for privacy and to enclose the service area
screening needed to insure privacy and create enclosure
150'
immediate access to living areas of house
service and play area
entry
lightly screened entry
water & sewage
88'

PLOTTING LOCATION OF BUILDINGS

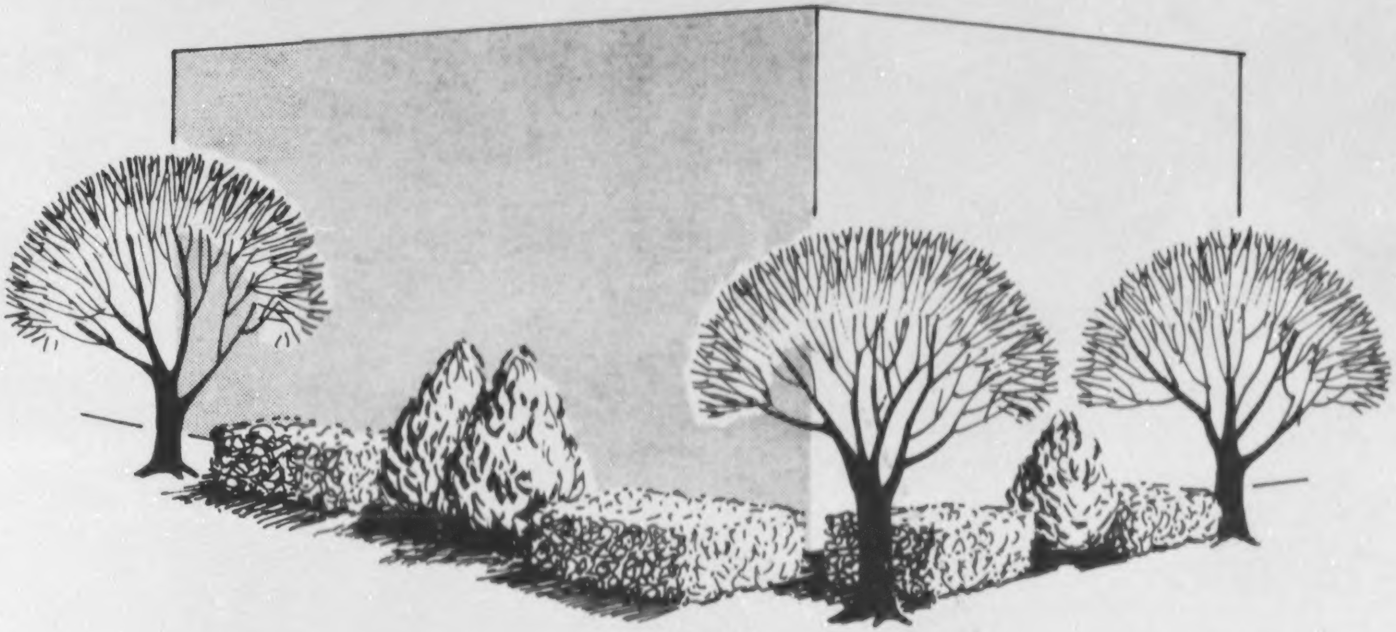

PIN "B"
PIN "C"
corner II
corner III
corner I
corner IV
PIN "A"
lot line
PIN "D"

AREA LAYOUT PLAN


back of site kept fairly open to visually borrow space from other properties
play area
N
wind
screening for privacy and to enclose the service area
screening needed to insure privacy and create enclosure
private area
terrace
immediate access to living areas of house
service and play area
entry
lightly screened entry
public area
150′
88′

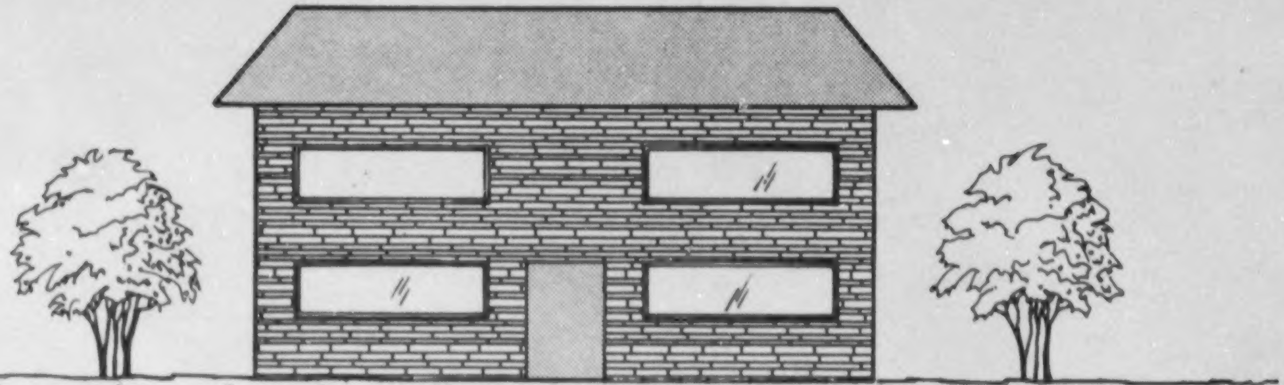

a
b
Symmetrical and Asymmetrical Balance
c
d
Asymmetrical - informal Balance

SIMPLICITY AND PROPORTION

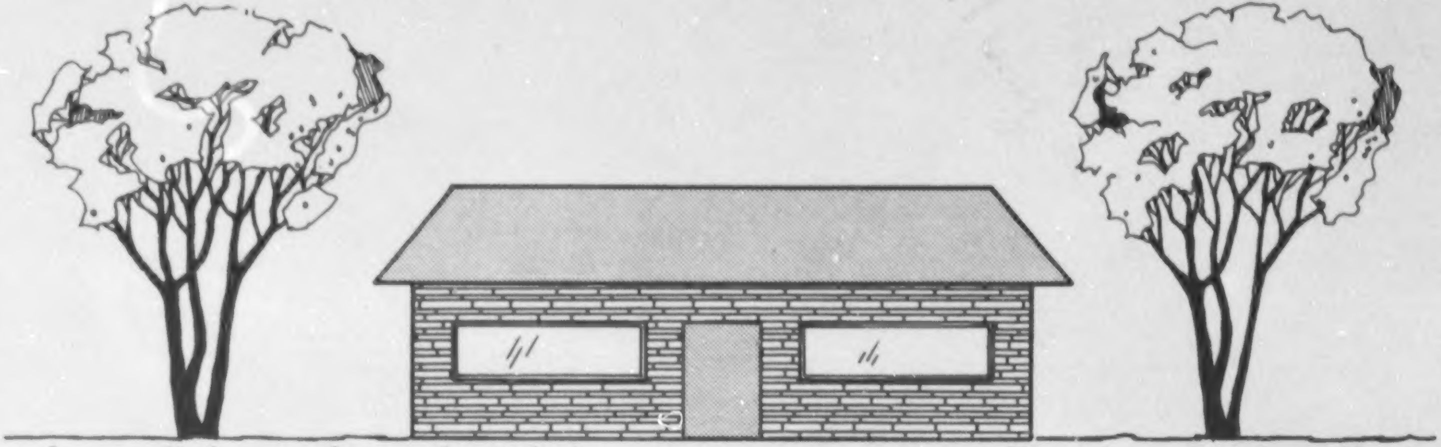


REPEAT THE USE OF LANDSCAPE PLANTS

PROPORTION IN LANDSCAPE DESIGN

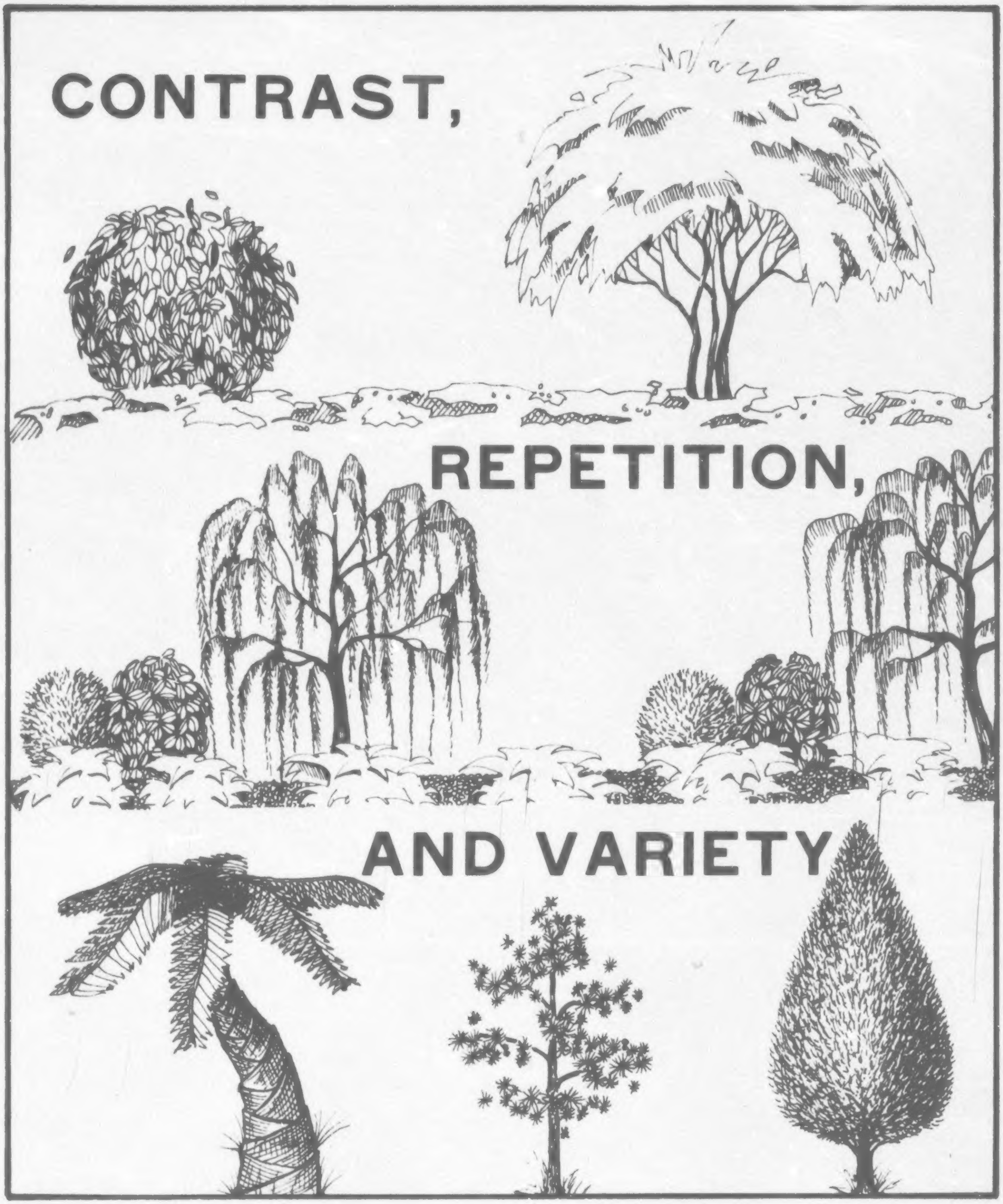


A large house framed with small trees appears even larger than it actually is.



A small house framed with large trees appears smaller than it actually is.

CONTRAST, REPETITION, AND VARIETY



Vocational Instructional Services

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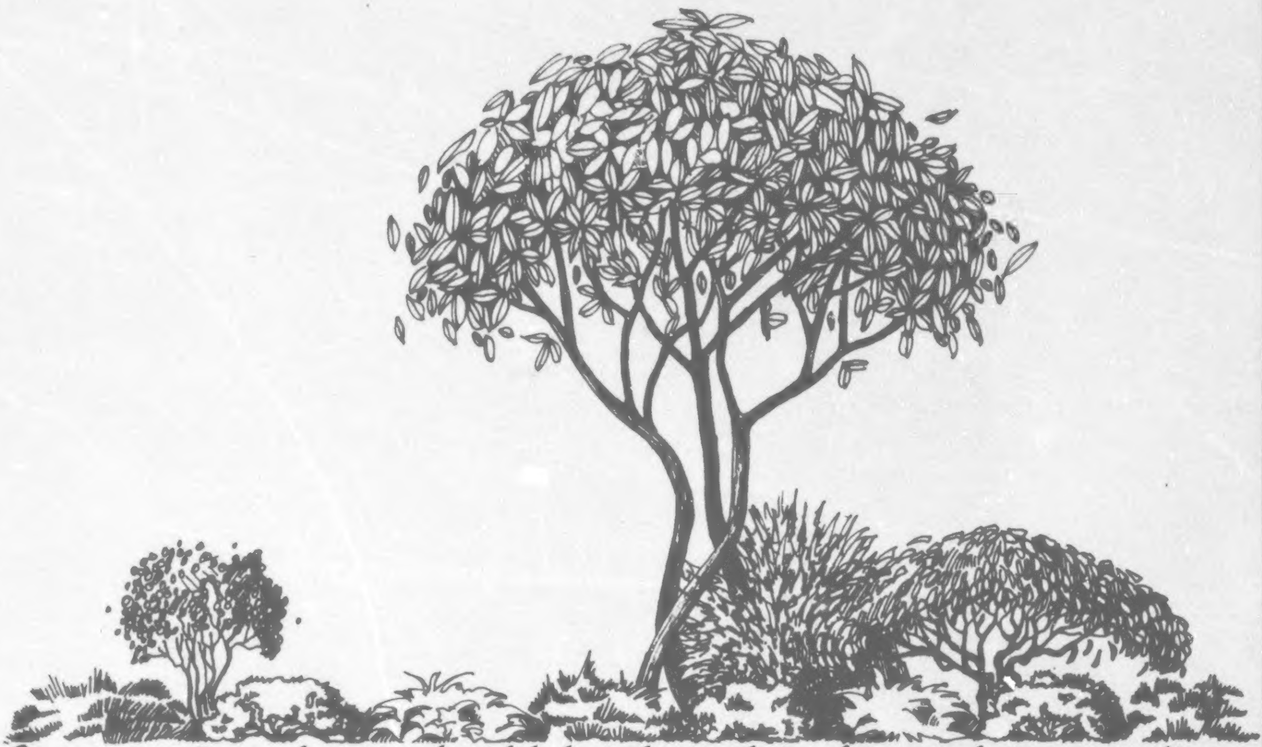
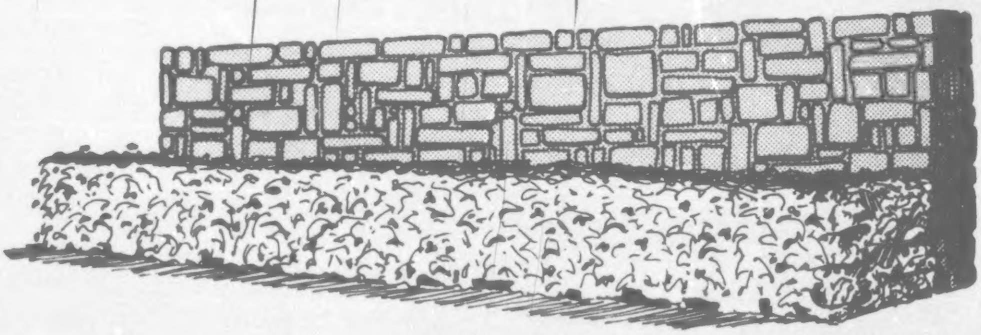
I-2
No. 7

PRINCIPLE OF SEQUENCE

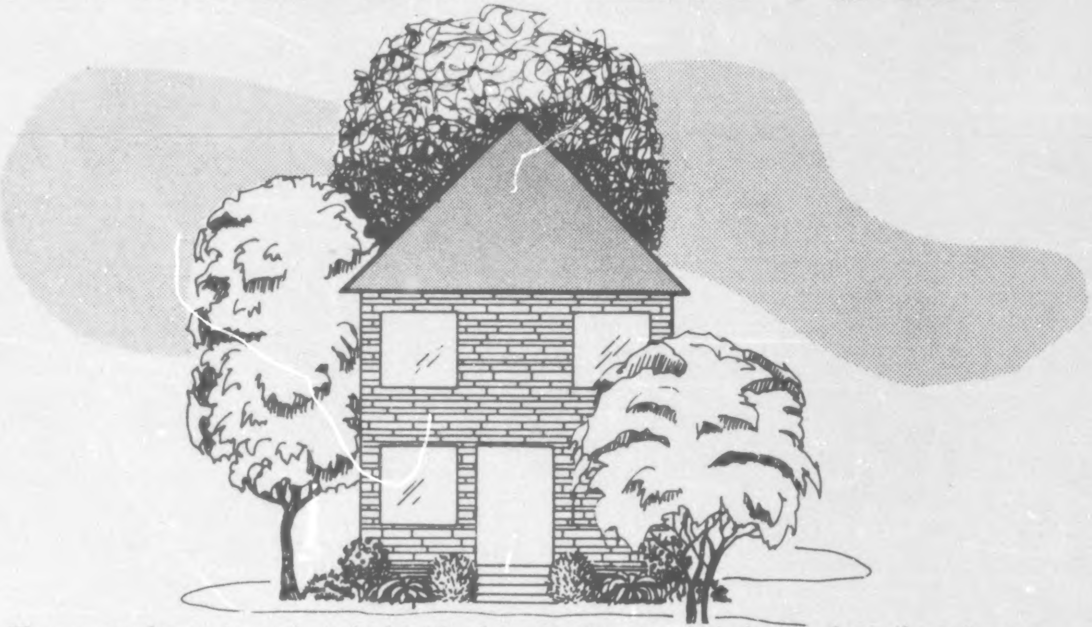


Low growing plants should be planted in front of intermediate growing plants. Tall plants should be placed behind.

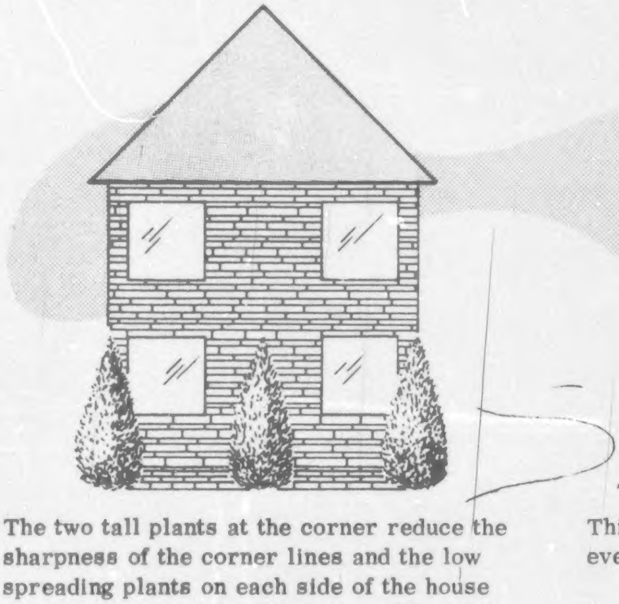


Groups and units should be wider than they are tall, as shown by the fence and border plants.

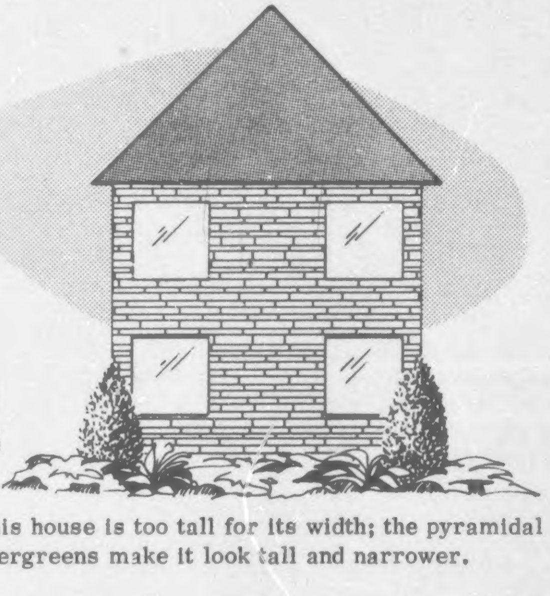
PRINCIPLE OF EMPHASIS



The narrow house is made to look wider by extending rounded planting from the entrance beyond each corner. Dominant plants should be placed at corners and accent plants at each side of the steps. All plants should be wide spreading and have dense foliage.

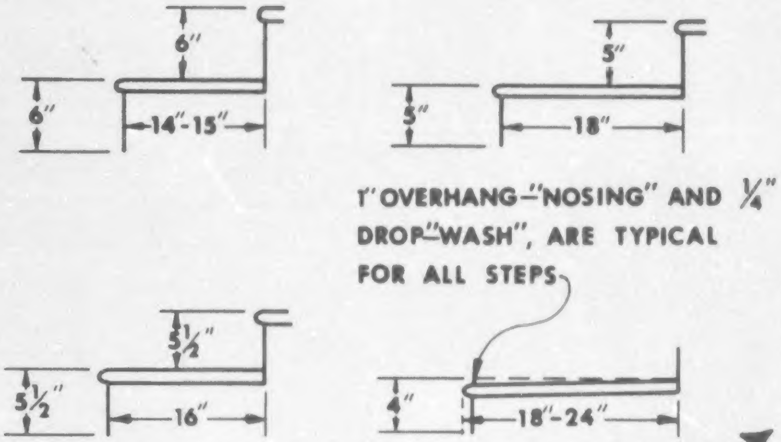


The two tall plants at the corner reduce the sharpness of the corner lines and the low spreading plants on each side of the house attract attention away from the height of the house.



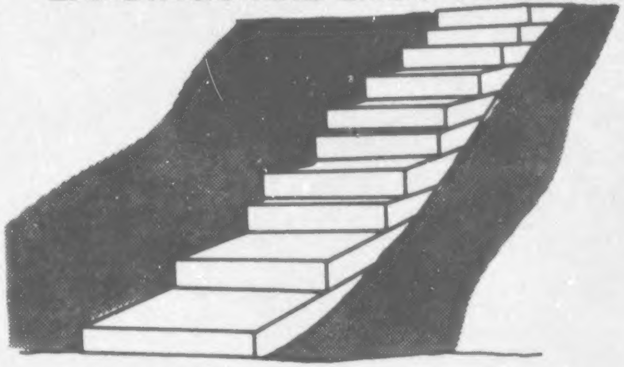
This house is too tall for its width; the pyramidal evergreens make it look tall and narrower.

EXAMPLES OF STEPS

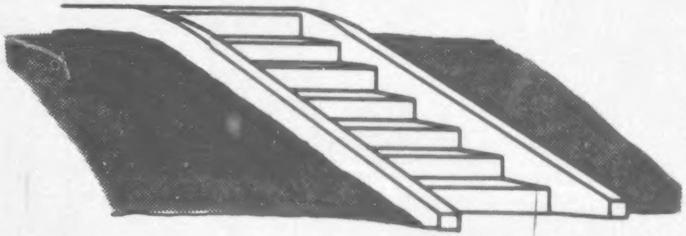


1" OVERHANG—"NOSING" AND ¼" DROP—"WASH", ARE TYPICAL FOR ALL STEPS

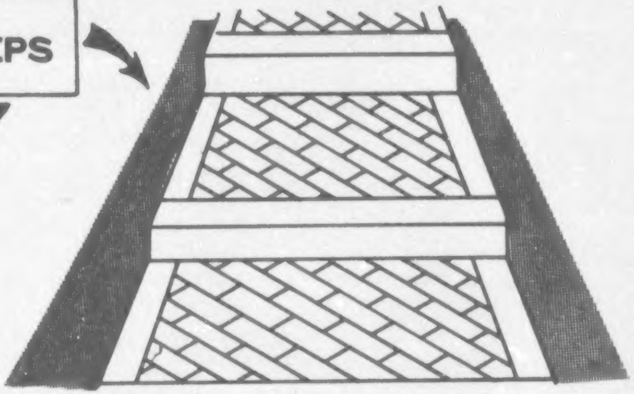
ALTERNATING STEPS WITH LANDINGS ARE EASY TO CLIMB



EXAMPLES OF SAFELY DESIGNED STEPS

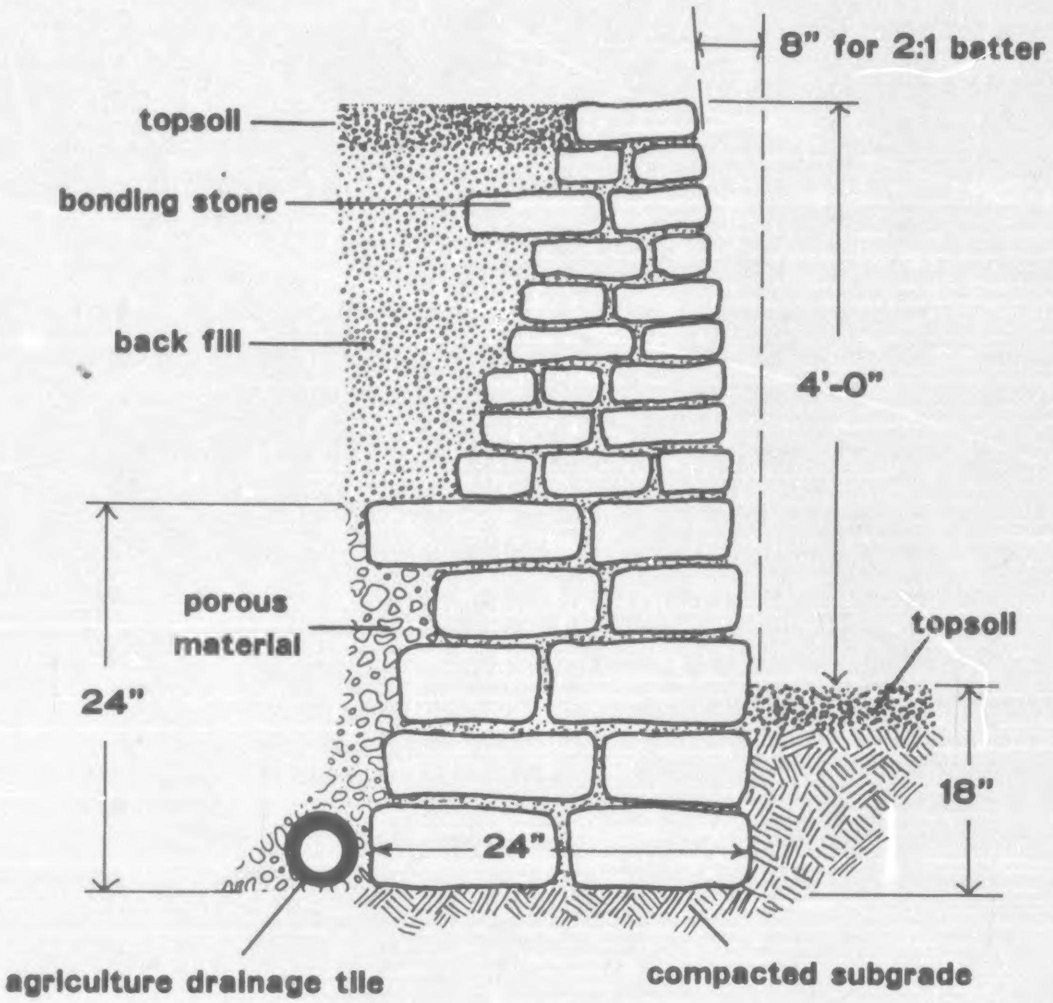


STEPS PLACED IN BANKS ARE ATTRACTIVE AND SAFE



ATTRACTIVE STEPS CONSTRUCTED OF BRICKS AND CROSS TIES

DRY WALL


8" for 2:1 batter
topsoil
bonding stone
back fill
4'-0"
porous material
24"
topsoil
18"
24"
agriculture drainage tile
compacted subgrade

Vocational Instructional Services
Agricultural Education

I-3
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unite I: Developing and Maintaining the Landscape

Topic 3: Maintaining the Landscape

Note: All terms underlined are included in the "Glossary of Terms."

1. Landscape Maintenance

It is impossible for a landscape to maintain its beauty without a certain amount of maintenance. Landscape maintenance includes those activities that are necessary for properly caring for plants. Most maintenance activities require a planned schedule and normally include mowing the lawn, cutting and pulling grass and weeds, pruning trees and shrubs, trimming edges, fertilizing, watering, and controlling insects and diseases.

The trend in landscape maintenance has been to select plants and a landscape design that will require a minimum of maintenance. A number of factors such as choice of plants, soil condition, available moisture, amount of sun and shade, size of plants, and exposure are factors which influence maintenance requirements.

2. Watering and Fertilizing the Landscape

The most critical decisions made by home owners in regard to landscape maintenance are the proper amount, time, and frequency of watering. The requirements vary from season to season and plant to plant. A rule of thumb used by many is to water as little as possible while maintaining maximum plant growth. Too much water is just as harmful as too little.

Transparency No. 1

The following principles should be helpful in making the decision as to the amount, time, and frequency of watering:

1. Water must be placed where it is needed, since most of its movement is downward.
2. Water should not be applied faster than the soil will absorb it.
3. To prevent the elimination of oxygen in the soil and at the same time flush salts from the surface layer of the soil, watering depths should be varied.
4. Watering early in the morning prevents excessive evaporation and aids in the control of fungus and other diseases, particularly in lawns.
5. Water should be applied in an amount that will meet the needs of most of an area.
6. Water should be applied to a depth that will encourage deeper root depth. Building a soil basin around trees and shrubs will cause the water to penetrate the soil much deeper around the plants.
7. Mulching reduces water and fertilizer requirements.
8. The water system should be checked to determine the amount of water distributed in a given time period. A container may be used to determine the amount of water

being destributed by a sprinkler. If an open-ended hose is used to water individual plants, it may be necessary to catch the water for a short period of time to determine distribution.

9. A sprinkler system should be used when possible. Hand watering is erratic and expensive.

Trees and shrubs, because of their larger root system, require more water than grass or bedding plants. However, they do not have to be watered as often.

Transparency No. 2

Four methods used to water trees and shrubs are (1) prepared basin, (2) open holes, (3) subsoil irrigation, and (4) drip irrigation. Drip irrigation was first used in Israel and is being used extensively in orchards in this country. Its principal advantage is a minimum of water is required. When using one of the first three methods, water should be applied from the dripline to the trunk. It might be an advantage to move the hose or lateral from one side of the plant to the other periodically when using drip irrigation.

Fertilizing

The rate and analysis of the fertilizer is of utmost importance in maintaining proper plant growth. Over fertilization can also give the home owner problems. Visible symptoms of plants with nutritional deficiencies are undersized leaves, yellow or chlorotic leaves, sparse foliage, and poor twig growth.

Selecting a fertilizer based on a soil test is the most accurate method of selection. The sample should be taken from a number of areas and be representative of the root growing area of the landscape. An explanation of the procedure to follow in collecting a soil sample is given in Unit E, Topic 5.

Trees, shrubs, vines, and ground cover normally should be fertilized twice a year. The applications may be made from early spring until late fall depending upon the area of the state.

Trees usually receive enough fertilizer if the lawn is adequately fertilized, but it may be necessary to feed them separately. Deciduous trees require more fertilizer than narrow-leaf evergreens. A rule of thumb used in making fertilizer recommendations is $1\frac{1}{2}$ to $2\frac{1}{2}$ pounds of fertilizer for each inch of diameter in the tree trunk. The diameter of the tree is measured at about $2\frac{1}{2}$ feet above ground level. The recommended rate of fertilizer for broadcasting and mass planted plants is $2\frac{1}{2}$ to 5 pounds per 1,000 square feet.

Transparency No. 3

Fertilizers are available in two forms, dry and liquid. The form to use will depend upon the equipment available. Each form has an advantage. Plants absorb liquid fertilizers more readily, but the dry form lasts longer. The three methods used to apply fertilizers to ornamental plants are the fertilizer injector system, broadcast (either mechanically or by hand), and punch bar method.

Transparency No. 4

Using the punch bar method of fertilizing plants, the grower punches a series of holes in an area from within about two feet of the tree trunk to two feet beyond the dripline. The holes are two inches in diameter, 12 to 18 inches deep, and are spaced two feet apart around the tree. The recommended rate of fertilizer is equally distributed among all of the holes. After the fertilizer is applied, the holes may be filled with sand or a mixture of sand and peat. If the soil around the tree is dry, the entire area around the tree should be watered.

Soil amendments are not considered as fertilizers but they may be applied at the same time. Three of the most important soil amendments in the maintenance of landscape plants are iron chelate, ferrous sulphate, and magnesium. Broadleaf evergreens, hollies, and some other plants require a soil pH between 5.0 and 6.0. In soils with a higher pH, the above plants develop chlorosis (yellowing of leaves). Chlorosis is caused by a deficiency of iron or magnesium. The high soil pH prevents these elements from being available to the plant. The deficiency may be corrected by either spraying the foliage with one ounce of ferrous sulphate per gallon of water, or drenching the plant with one ounce of iron chelate per 10 gallons of water. Sometimes as much as six weeks is required after the application for the plant to resume its natural green color.

3. Pruning and Trimming Trees and Shrubs

Except for formal hedges, the landscaper would like to grow plants that do not need pruning. However, most trees and shrubs will require some pruning. Plants are pruned for the following reasons:

1. To remove injured, diseased, and dead branches;
2. To remove old or surplus branches;
3. To develop and maintain growth, size, and shape;
4. To influence flowering and fruiting; and
5. To establish a balance between the root and branch systems.

Trees and shrubs are generally pruned during the dormant season, but some pruning may be done during the growing season. Broken branches and torn bark should be pruned as soon as it is noticed. Old plants that flower poorly are pruned to rejuvenate by severely cutting the plant back. Since different kinds of shrubs should be pruned differently, a discussion of the pruning of different groups of plants is given.

Trees

Trees can be pruned most anytime, but there are certain advantages and disadvantages in pruning during certain seasons. The best time to prune trees to the desired shape is when they are in full foliage. The dead and diseased branches are easier to see at this time. Because of the rapid healing of wounds in the spring, this is a good time to prune large trees. However, some trees such as birch and elm bleed profusely during the spring; so they should be pruned during the summer when they are less likely to bleed so profusely.

A part of the root system is destroyed in the transplanting of a plant. In order to improve the probability that the transplanted tree will grow, the above ground portion of the tree should be pruned to balance it with the root system.

Transparency No. 5

The desired shape of the tree will influence pruning. Examples of two methods of pruning a tree are shown in the preceding transparency. The gardener should be familiar with the procedure for pruning both large and small limbs and the length to leave the stub.

When pruning branches larger than one inch in diameter, a series of cuts should be made to prevent tearing of the bark. The first cut should be an undercut on the limb 10 to 12 inches from the final cut.

The second cut is made from the top and completes the removal of the limb. Following this procedure will remove the heavy weight of a limb. The length of the stub left on the tree is important. If the stub is too long, the dead stub is vulnerable to insects and diseases. If the cut is too close to the trunk or main branch, the stub will die back into the tree. The length of the stub should encourage rapid healing and limit vulnerability to insects, etc.

Transparency No. 6

There are many ways in which trees can be damaged. A few common problems of trees and ways of pruning them are shown in the above transparency.

Broad-leaf Evergreens

Some of the plants included in this group are hollies, abelias, ligustrums, euonymus, viburnums, barberries, boxwoods, and privets. These plants should be pruned before growth begins in the spring. They may be pruned anytime during the dormant season, but they will appear to be bare for a longer period before growth starts. Some pruning may be done in the summer.

Hedges normally consist of plants within this group. They may be trimmed or sheared to form most any shape.

Transparency No. 7

A rounded or more pointed top is preferred because a flat-topped hedge is difficult to maintain and clip. It also is more easily broken down by weather and other causes.

Fast Growing Conifers

Included in this group are such plants as cedars, arborvitaes, pines, firs, junipers, hemlock, and spruce. These should be pruned in the spring and may be pruned in mid-summer if it is needed.

Other Evergreens

Pyracantha, nandina, azalea, and camellia belong to this group. Pyracantha and nandina are not pruned unless it becomes necessary, for they produce berries on wood more than two years old.

Camellias are usually pruned after the plant blooms, but they may be pruned during the dormant season if the plant needs thinning.

The objective in pruning evergreens is to produce a more compact or bushier plant. Pruning the growth at the ends of young shoots forces the plant to make new growth along the branches. All evergreens cannot be pruned at the same time. The time to prune will depend upon the growing season. Some evergreens have a short period of growth, while others grow during the entire growing season.

When shrubs within this group become overgrown, they should be cut back to about one foot of the ground. Many of the narrow-leaved evergreens produce a browning effect on the foliage during the fall of the year. This is a natural pruning process and is comparable to the shedding of leaves of deciduous plants.

Chinese juniper and the pyramidal forms of arborvitae can be sheared the first or second week of April in the warmer parts of the state and the first part of May or June in the colder areas. Narrow-leaved evergreens, such as cypress, juniper, cedar, and arborvitae should not be pruned behind the foliage on the tips. Buds are formed on these twigs, and the plant may be damaged beyond repair.

Spring Flowering Shrubs

Dogwood, forsythia, spirea, and flowering quince are a few of the spring flowering shrubs. The spring flowering shrubs that bloom before the last of June form their blooms from the growth of the previous year. If these plants are pruned before they bloom, a number of the blooms will be cut off; therefore, they should be pruned after they bloom.

Summer Flowering Shrubs

Included in this group are crape myrtle, althea, and buddleia. These shrubs should be pruned while they are dormant. The flowers are produced on new wood.

Pruning Methods

Transparency No. 8

Examples are shown of proper and improper pruning. The gardener can learn a lot about pruning by observing the characteristics and growth habits of plants. The most common trees and shrubs have two types of bud arrangements on the twigs and branches. The bud arrangement is responsible for the growth habit of the plant, and a gardener can exert considerable influence on the future pruning of the plant by using care in the selection of the terminal bud.

The two bud arrangements are alternate and opposite, Plants having the alternate arrangement will usually be rounded, pyramidal, inverted pyramidal, or columnar in shape. Plants with an opposite bud arrangement usually have a rounded form and a rounded crown.

Transparency No. 9

The position of the buds left on a stem after pruning determines the direction in which the new shoot will grow. The bud on top of the twig will probably grow upward at an angle, while the bud on the side of the twig will grow outward and to the side in which it is directed.

Both buds on plants having opposite buds will usually grow when the pruning cut is made above a pair of buds in a lateral position.

Pruning Tools

In order to do a good job of pruning, certain tools are needed. Generally, the purchase of high quality tools is cheaper when useful life is used as a basis for determining value. The size to purchase will depend upon personal preference.

4. Staking and Guying

In order to protect the plant and to obtain the desired size and growth, it is often necessary to use stakes and construct guying. When it becomes necessary to remove old stakes and replace them, the new stake should be driven in the old hole to prevent damage to the root system of the plant. Using a stake drive will expedite the driving of stakes.

Transparency No. 10

Small trees, having a caliper of three inches or less, can be supported by threading wire through a section of garden hose, placing the threaded hose around the tree, and attaching the wire to the stake. A canvas fire hose or durable plastic materials may also be used in place of the garden hose.

Some trees do not need support, but they do need protection. Frames are constructed around plants needing protection.

Eyebolts are useful in guying large trees, as they prevent wire or cable damage to the tree. Short pieces of wood may also be used to protect the tree from wire or cable damage. The wood pieces must be checked periodically and reset to prevent the bark from growing around the pieces.

Split crotches of trees are repaired by bolting the split areas back together and by using eyebolts and wire to help support the limbs. The bolts used to repair the split crotch should be cut off just behind the nut. Both ends of the bolt and the nut(s) are covered with tree dressing. The splitting crotches can often be prevented by supporting the limbs with eyebolts and wire.

5. Treatment of Tree Wounds and Decayed Areas

Care should be taken to prevent the injury of plants in the landscape. Injury caused from the use of mechanized equipment in the construction of structures on the landscape site has caused the death of valuable plants. Large trees may be protected during the period of construction by tying boards around the tree trunk. Small plants can be protected by building protective frames around them.

Transparency No. 11

Plants may overcome minor injury without treatment, but severely injured trees should be treated. Bark injury is treated by removing all stubs (lips of wood) and decayed wood from the wound. Since a pointed ellipse (boat shape) aids callus formation, which is the first stage of healing, the injured area should be made into this shape. Water drainage is provided by cutting the bark and wound area into a "V" shape. The cambium should be painted with shellac following the removal of the decayed wood and the shaping of the injury. After the shellac has dried, a tree paint or wound dressing is applied over the shellac.

A number of different kinds of wound dressings are available. Those used most often are orange shellac, asphaltum, and commercial tree paint. It may be necessary to repaint the area before the wound heals. If it is repainted, the new growth should not be covered with the paint.

Decayed areas in a tree are treated by removing the dead wood and painting the walls of the cavity with tree paint. Bolts may be used if needed to make the tree rigid. The cavity is then filled with concrete.

Laboratory Exercise No. 1

Activity:

The application of fertilizer by using an injector system, mechanical broadcasting, and the punch bar.

Materials:

Fertilizer injector, root feeder, or a similar piece of equipment
Fertilizer (dry and liquid)
Hopper or centrifugal spreader
Punch bar
Garden hose

Procedure:

- A. Injector system
  1. The water soluble fertilizer is placed in the injector tank.
  2. An explanation is given of the operation of the system.
  3. System is turned on.
- B. Mechanical broadcasting
  1. The spreader is filled with fertilizer.
  2. An explanation is given as to the procedure used to determine the rate of distribution and the operation of the spreader.
  3. A small area is fertilized.
- C. Punch bar method
  1. Holes are punched the proper distance apart in the root area around a plant.
  2. The rate of application, based upon the size of the plant, is determined.
  3. The fertilizer is equally distributed among the holes around the plant.
  4. Peat or sand is used to complete the filling of the holes.
  5. The area around the plant is watered if it is dry.

Laboratory Exercise No. 2

Activity:
The proper procedure used for pruning large limbs

Materials:
Pruning saws

Procedure:

1. The first cut is made on the underside of the limb 10 to 12 inches from the final cut. The limb is cut until the saw binds.
2. The second cut is made on top of the limb and above and slightly farther out the limb than was the first cut. The limb is removed.
3. The final cut is made.
4. Tree dressing should be applied to the cut surface.

Laboratory Exercise No. 3

Activity:
Repairing the split crotch of a tree

Materials:
Eyebolts
Wire or cable
Bolts or nuts

Procedure:

1. The split crotch is pulled together, and holes are drilled through the trunk in the area of the split crotch. The number of holes that should be drilled is determined by the length of the split and the size of the tree trunk.

2. Bolts are put through the holes. Washers should be placed over each end of the bolts, and the nuts are tightened snugly on the bolts and against the washer.
3. The excess ends of the bolts beyond the nuts are removed, and the ends are painted with tree dressing.

Laboratory Exercise No. 4

Activity:
Filling a tree cavity with concrete

Materials:

Concrete	Tree dressing
Chisels	Hammer
Gouge	Concrete trowel

Procedure:

1. The decayed materials are removed from the cavity. The living wood of the tree should be exposed in the cavity.
2. The walls of the cavity are painted with tree dressing, and bolts are used to keep the tree rigid, if they are needed.
3. The concrete is placed inside the cavity and is finished on the exterior surface.

References:

1. "Modern Pruning Methods," Texas Agricultural Extension Bulletin 977.

2. "Landscaping the Home and School Grounds," Agricultural Education Department, Clemson University, Clemson, SC.

WATERING PRINCIPLES

PLACE WATER WHERE NEEDED

BASE RATE OF APPLICATION ON ABSORPTION

VARY WATERING DEPTH

WATER EARLY IN THE MORNING

APPLY PROPER AMOUNT

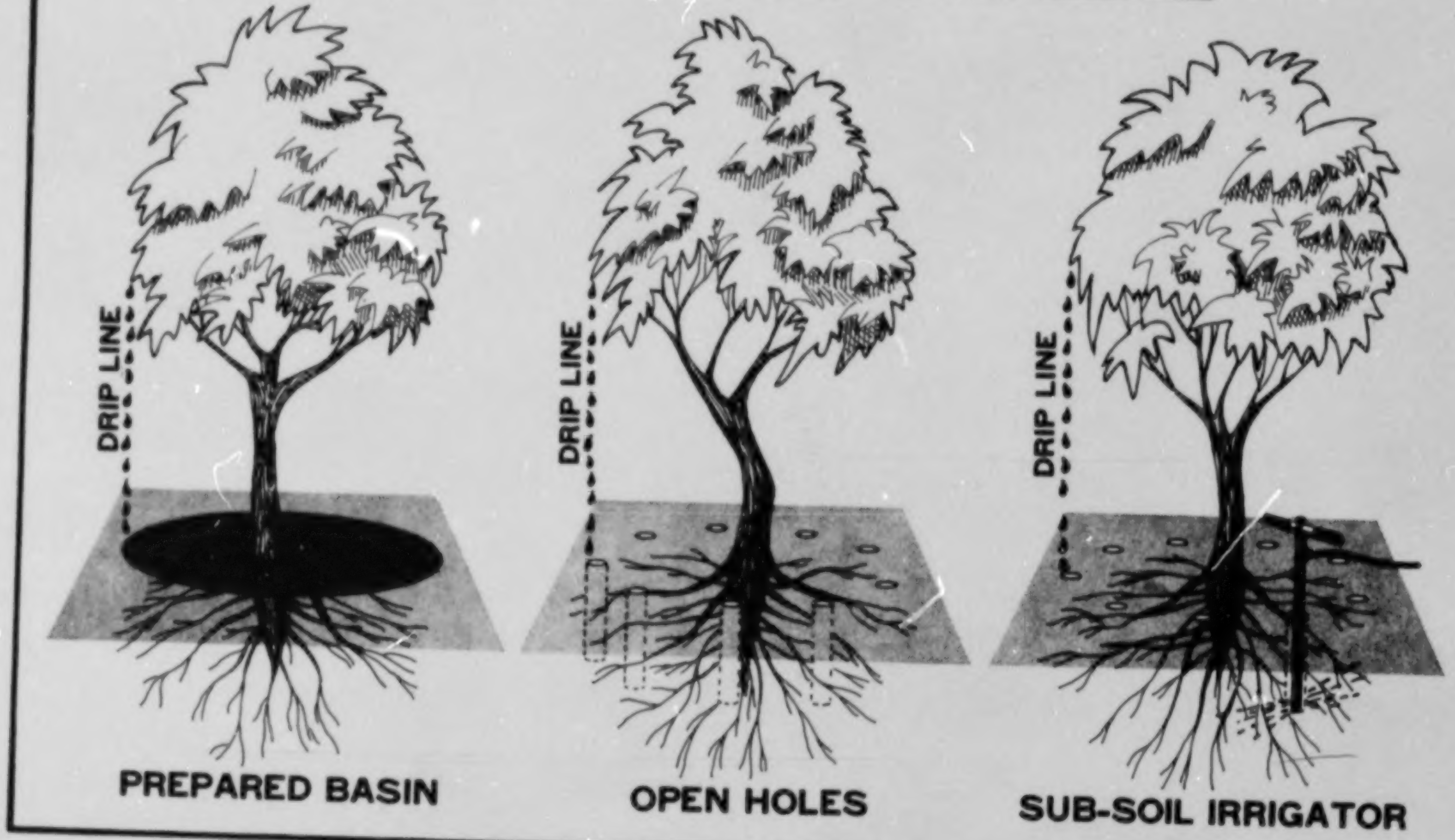
APPLY TO PROPER DEPTH

ADD MULCH TO REDUCE WATER REQUIREMENTS

DETERMINE THE AMOUNT DISTRIBUTED IN A GIVEN PERIOD OF TIME

USE SPRINKLER SYSTEM IF POSSIBLE

Methods of Watering Trees and Shrubs

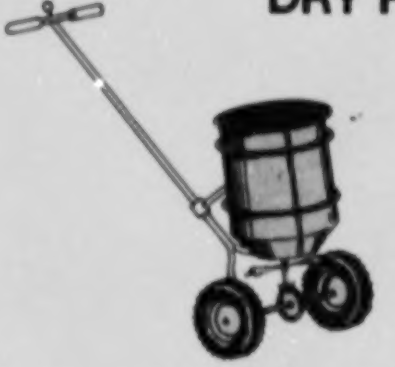

DRIP LINE
DRIP LINE
DRIP LINE
PREPARED BASIN
OPEN HOLES
SUB-SOIL IRRIGATOR

Pre-Lab, CVAE and VEH Horticulture

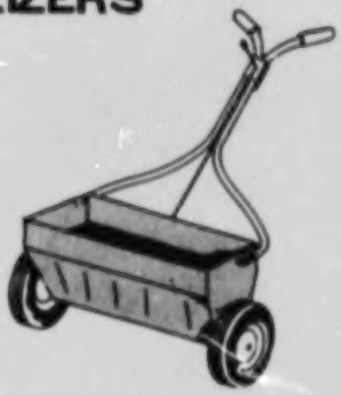
I-3
No. 2

MECHANICAL METHODS OF APPLYING FERTILIZERS

DRY FERTILIZERS

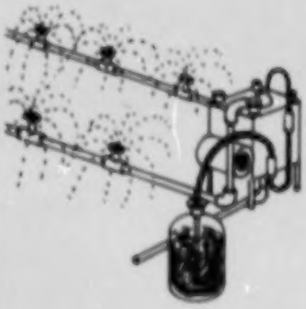


CENTRIFUGAL SPREADER

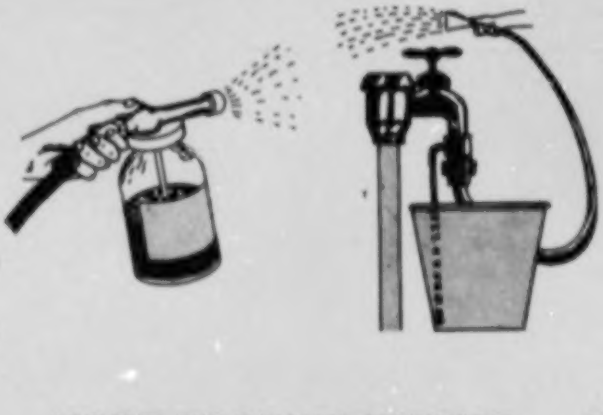


HOPPER SPREADER

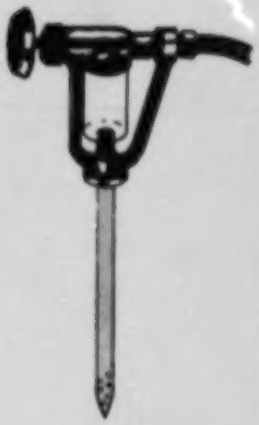
LIQUID FERTILIZERS



FERTILIZER INJECTOR

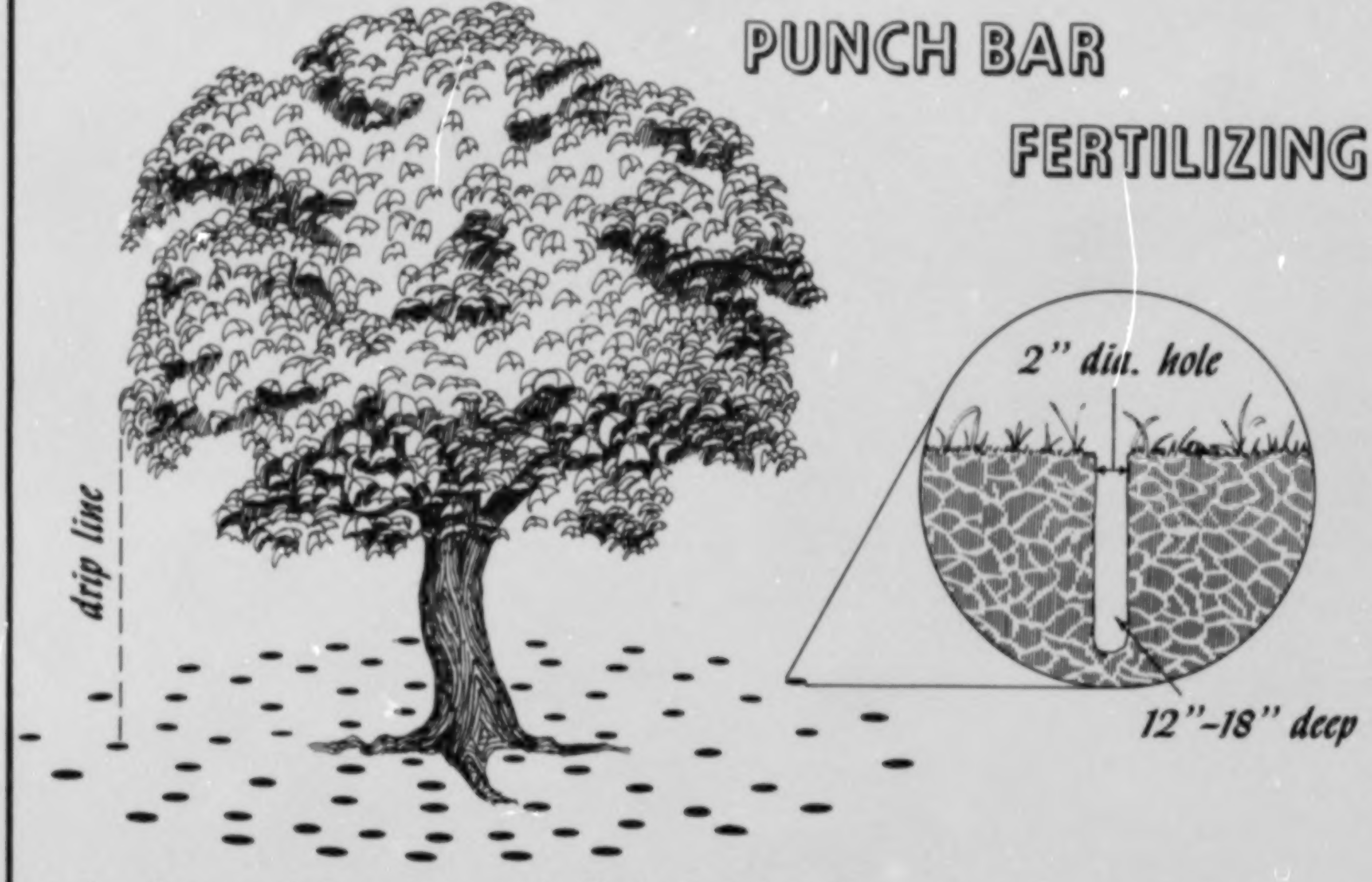


HOSE PROPORTIONERS



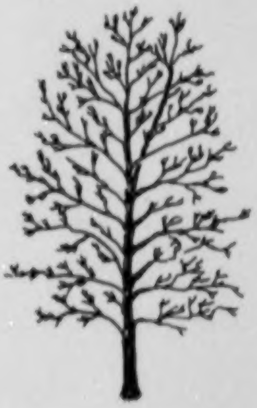
ROOT FEEDER

PUNCH BAR FERTILIZING

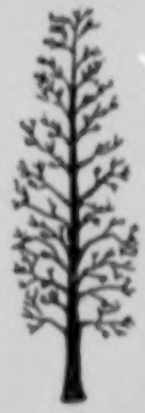

drip line
2" dia. hole
12"-18" deep

2 feet between holes. pattern 2'-4' beyond drip line.

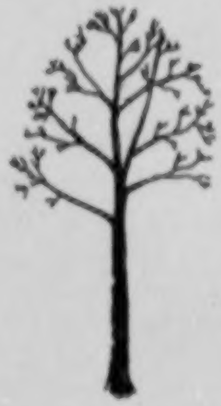
Pruning Trees



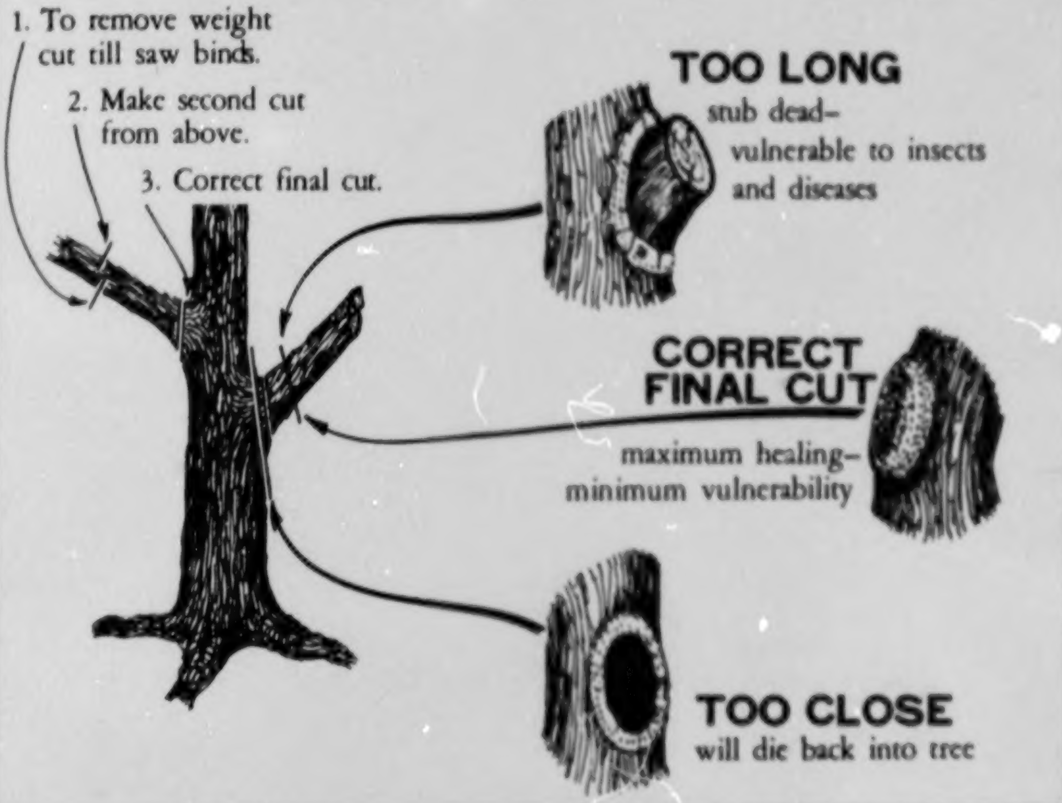
UNPRUNED



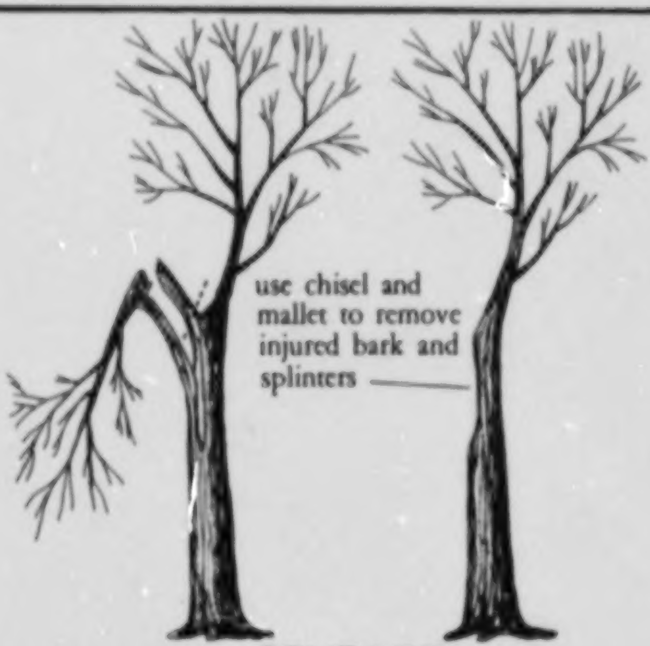
PRUNED



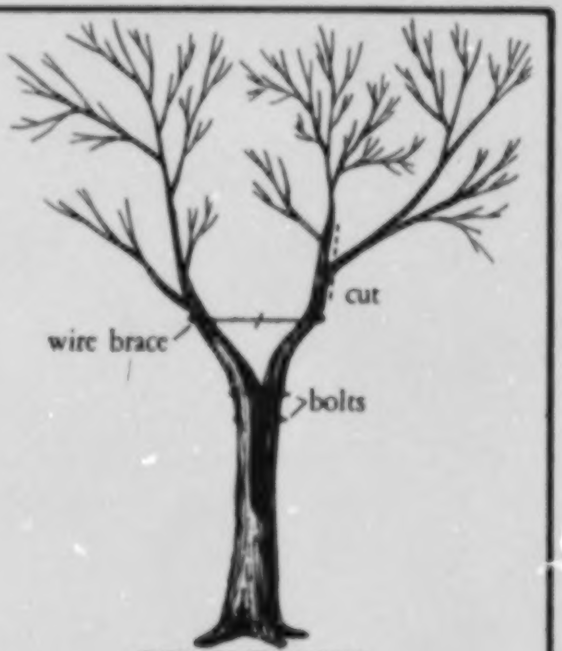
PRUNED


1. To remove weight cut till saw binds.
2. Make second cut from above.
3. Correct final cut.
TOO LONG
stub dead–vulnerable to insects and diseases
CORRECT FINAL CUT
maximum healing–minimum vulnerability
TOO CLOSE
will die back into tree

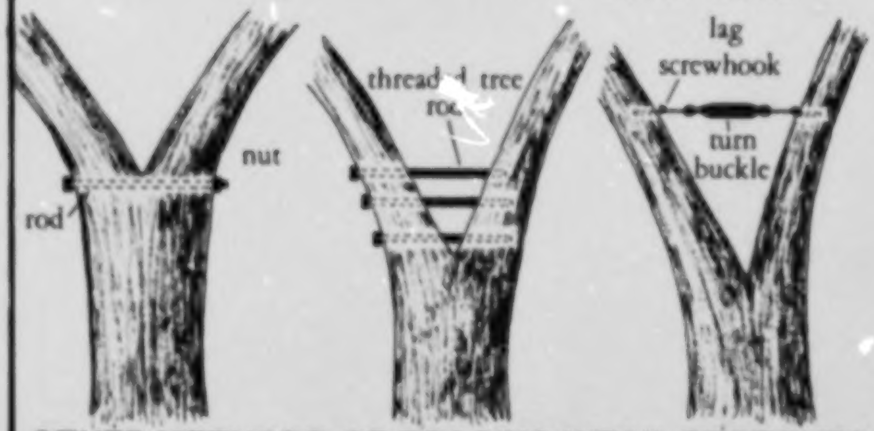
PRUNING & CARING FOR TREES


use chisel and mallet to remove injured bark and splinters

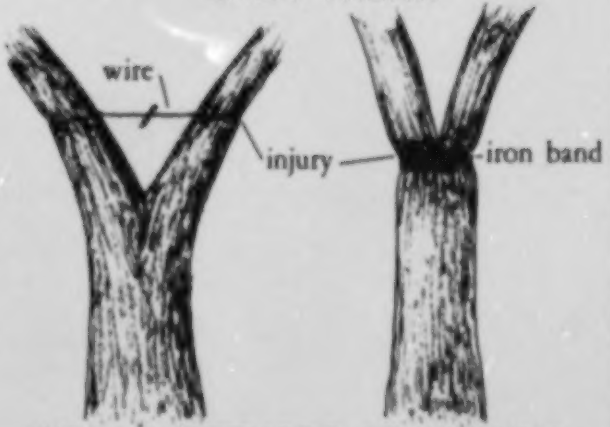
SPLIT LIMB


cut
wire brace
bolts

SPLIT TRUNK


rod
nut
threaded tree rod
lag screwhook
turn buckle

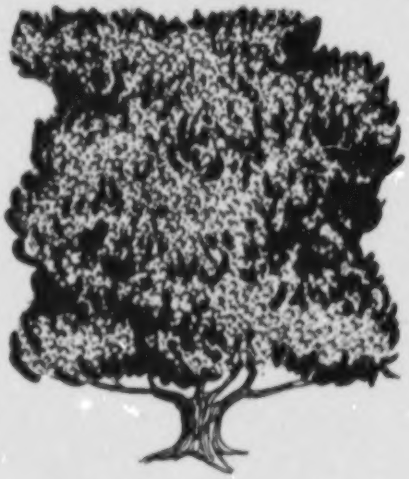
OTHER METHODS OF BRACING WEAK CROTCHES


wire
injury
iron band

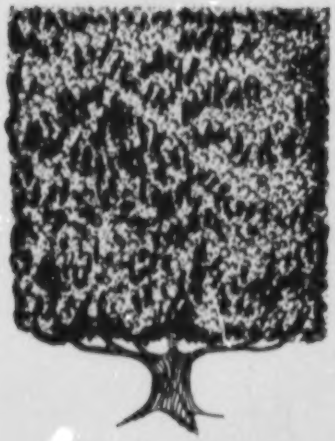
WRONG METHODS OF BRACING

PRUNING & SHEARING HEDGES

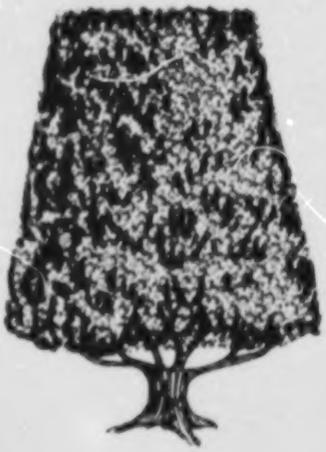
NATURAL HEDGE



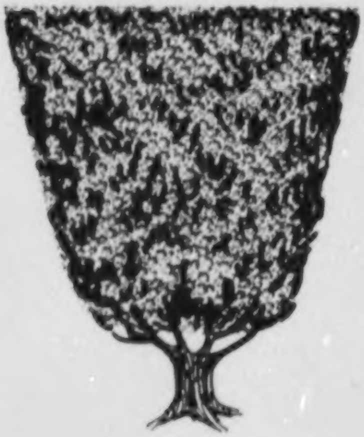
FAIR SHAPE



GOOD SHAPE

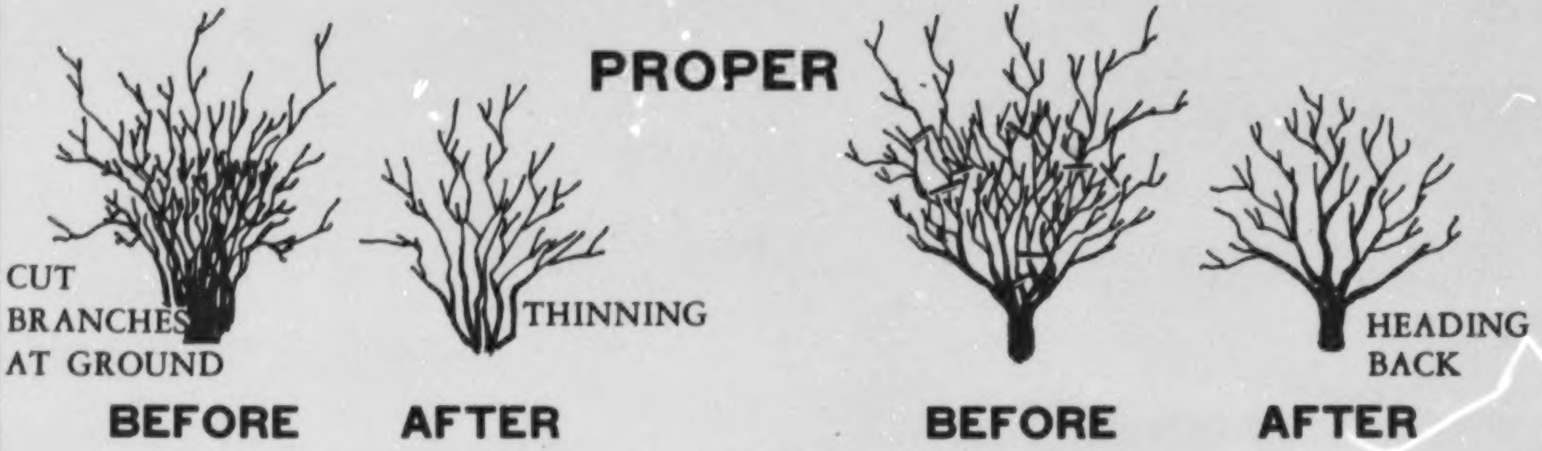


POOR SHAPE

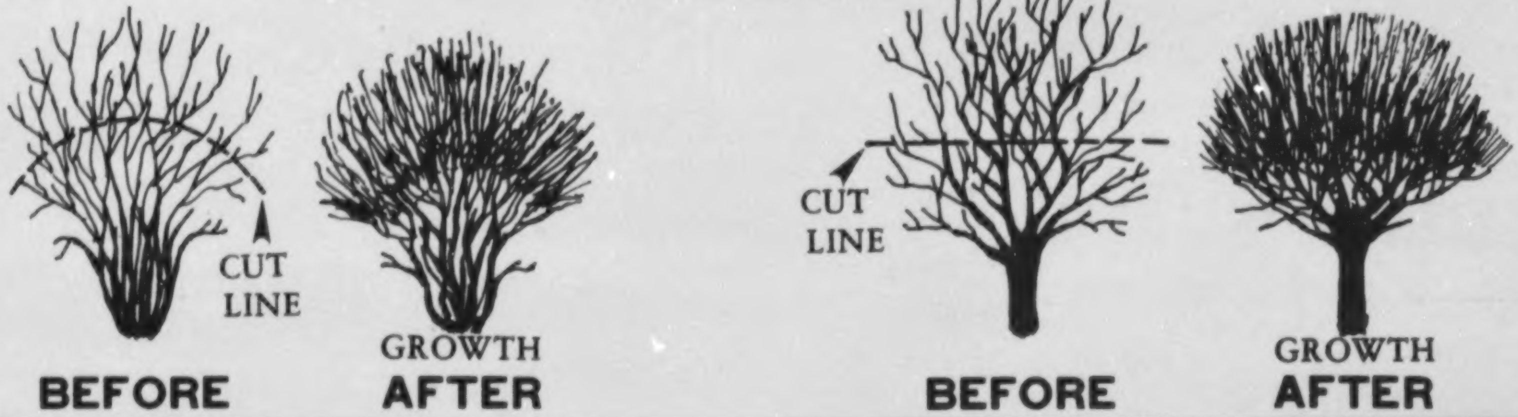


PRUNING

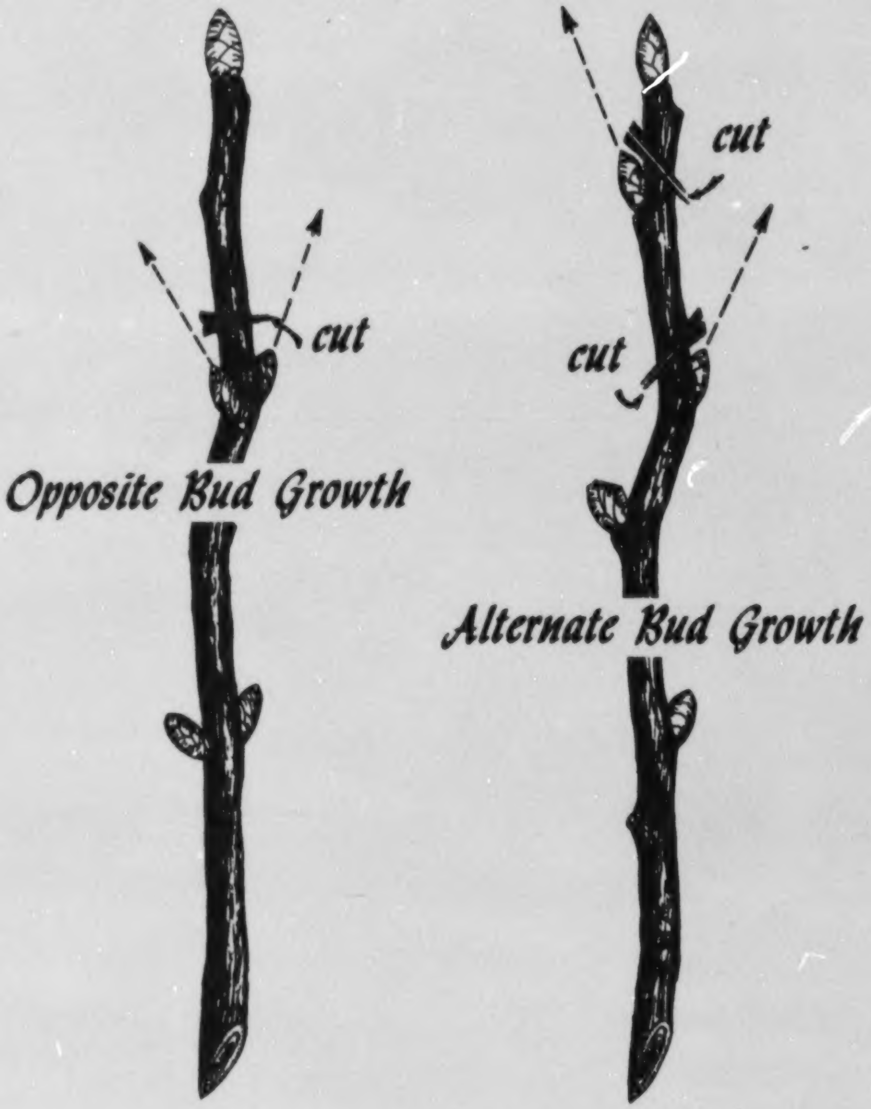
PROPER


CUT BRANCHES AT GROUND
BEFORE
THINNING
AFTER
BEFORE
HEADING BACK
AFTER

IMPROPER

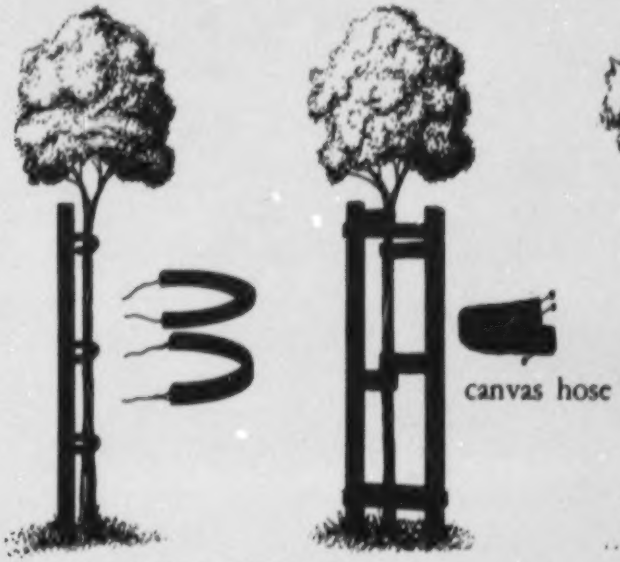

CUT LINE
BEFORE
GROWTH
AFTER
CUT LINE
BEFORE
GROWTH
AFTER

pruning plants

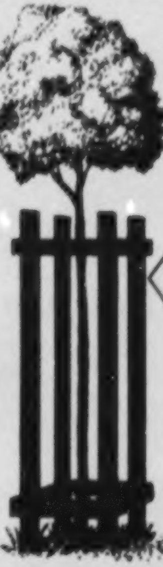

cut
cut
cut
Opposite Bud Growth
Alternate Bud Growth

arrows denote direction of growth when stem is pruned

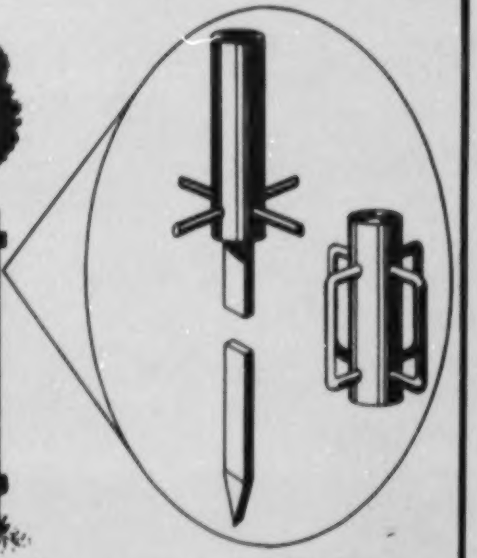
STAKING AND GUYING TREES


canvas hose

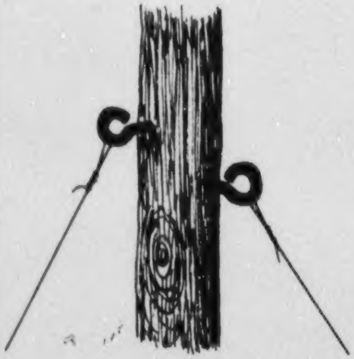
METHODS OF STAKING



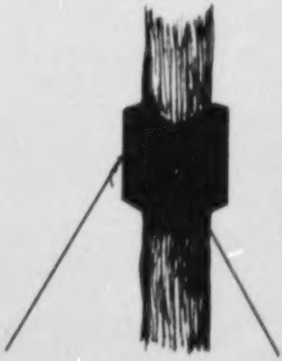
FRAMING FOR PROTECTION



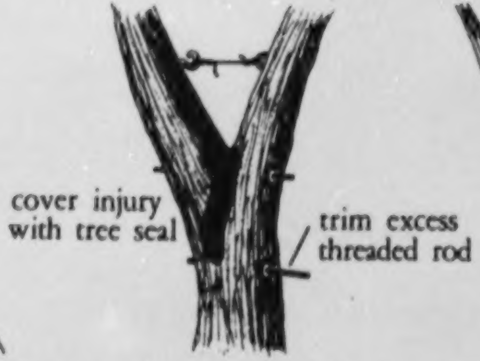
STAKE DRIVERS



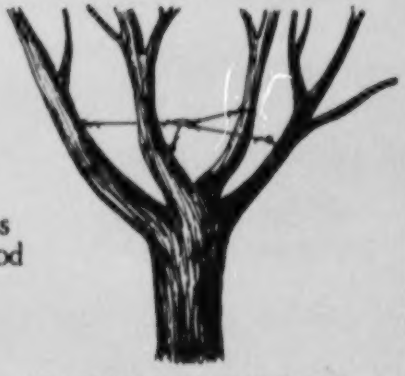
EYE BOLTS FOR LARGE TREES



BLOCKS OF WOOD

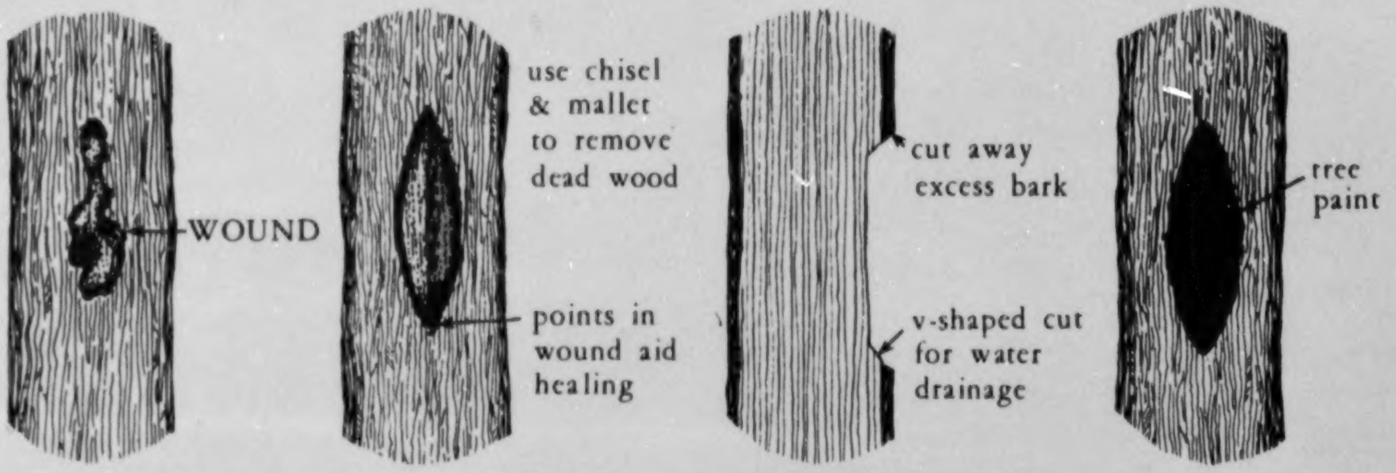

cover injury with tree seal
trim excess threaded rod

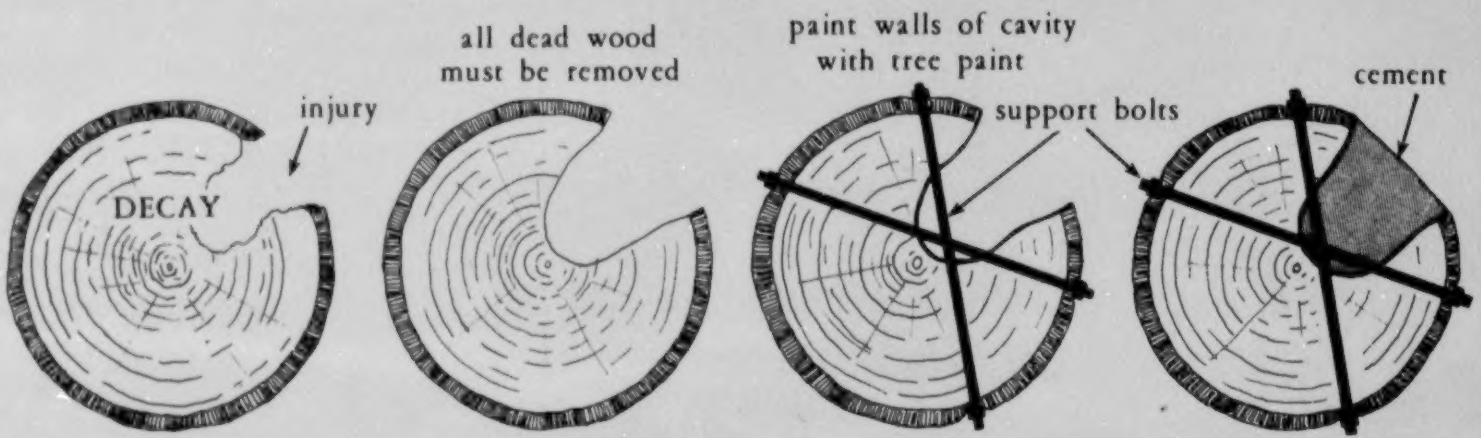
REPAIRING SPLIT CROTCH



CABLES FOR SUPPORT

TREATING TREE WOUNDS & DECAYED AREAS


WOUND
use chisel & mallet to remove dead wood
points in wound aid healing
cut away excess bark
v-shaped cut for water drainage
tree paint


injury
DECAY
all dead wood must be removed
paint walls of cavity with tree paint
support bolts
cement

CVAE AND VEH HORTICULTURE

Unit J: Establishing and Caring for Turf

Topic 1: Turf Grasses of Texas

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

The purpose of this topic is to familiarize students with the lawn grasses adapted to Texas, the methods of establishing the different varieties and strains, and the vegetative characteristics of turf grasses.

1. Introduction

The lawn is the most important single feature in a well-landscaped home area. It also is the first improvement which home owners and owners of commercial and public buildings plan after the home or building is completed. Although a lawn provides the setting for the entire landscape, its primary purpose is functional rather than aesthetic. A lawn eliminates soil erosion, reduces runoff, lowers surface temperature, muffles noise, reduces glare, and filters harmful pollutants from the air. Lawn grasses also contribute oxygen to the surrounding environment, as do other living plants.

Based on projections from a statewide survey made in 1964, more than $300 million are spent annually in Texas on home lawn maintenance. The principal expenditures are for labor, water, and equipment. It appears that the demand for those who provide lawn maintenance service is on the increase. Because of the demand for lawn grass sod, a number of nurseries are specializing in the production of lawn grasses.

2. Selecting a Turf Grass

The selection of a truf grass will depend upon the geographic location, available water, amount of shade present, and the amount of money the owner is willing to spend.

There are approximately 550 varieties of grass growing in the state, but only a few varieties are suitable for lawns. The essential food materials necessary for good grass growth is manufactured in the leaves of the plant. Since lawn grasses are mowed often, only a few varieties can withstand this type of treatment and still produce a desirable turf.

Turf grasses are classified into two categories, warm-season and cool-season. The warm-season grasses grow in the late spring, summer, and fall. The growing period for cool-season grasses is late fall, winter, and early spring.

WARM-SEASON TURFGRASS

The two most practical warm-season grasses grown in Texas are common Bermudagrass and St. Augustinegrass. Zoysia and centipede grasses are planted in some areas of the state where water is not available for irrigation.

Bermudagrass

There are a number of varieties of Bermudagrass, and each has a specific purpose. Common Bermudagrass is the easiest to propagate and is the one most often used for lawns. It may be propagated by seeds and will grow on a wide range of soils. However, it will not grow in a shaded area. Bermudagrass is spread by runners and underground rootstocks. It is resistant to most turf diseases.

There are a number of Bermuda turf grass strains that have been developed for specific purposes. Since the seeds of these strains are sterile, they must be established vegetatively. A discussion of the strains that might be used in Texas is as follows:

Tiflawn-This is an aggressive, disease-resistant hybrid Bermudagrass, developed at Tifton, Georgia. It has about the same size leaves and stems as common Bermudagrass and forms a dense turf when properly managed. Tiflawn is generally planted in heavily used areas such as football fields.

Texturf 10-It was developed by the Texas Agricultural Experiment Station and is a medium-textured, dark green variety. It has more wear-resistance than common Bermudagrass and is also used for athletic fields. Texturf 10 is very sensitive to chlorinated hydrocarbon pesticides.

U3-This is a strain of common Bermudagrass which was developed in Savannah, Georgia. It is more cold-tolerant, but is not as wear-resistant as Tiflawn or Texturf 10.

St. Augustinegrass

St. Augustinegrass is a broad-leaved perennial with stolons (runners) on the surface. It is not as cold-hardy as Bermudagrass and is best adapted for areas east and south of Ft. Worth. However, it grows satisfactorily east of a line from Vernon to Brady to Del Rio. St. Augustinegrass grows in shaded or open areas when adequate moisture and fertility are available. It remains green longer after frost than Bermudagrass.

St. Augustinegrass forms a dense, thick turf which usually crowds out all other grasses and weeds, if growing conditions are favorable. It should be cut at a height of 2 to 3 inches.

Common St. Augustine used as turf is susceptible to certain diseases (brown patch, decline, and leaf spot), is more susceptible to iron chlorosis than Bermudagrass, is attacked by insects (chinch bugs and white grubs), and requires more water than

Bermudagrass.

Floratam is a new variety of St. Augustinegrass developed by Texas and Florida Agricultural Experiment Stations. It is a vigorous, broad-leaved grass which is resistant to chinch bugs and decline.

Buffalograss

This is a low-growing perennial grass that is native to South Central Texas and areas westward and northward. It is one of the few grass species which has separated male and female plants. Buffalograss is cold-, drouth- and heat-tolerant. It is recommended for dry regions where watering facilities are not available. Surface growth may appear dry during extended drouth, but the roots are not easily injured. Mowing is not essential, but buffalograss lawns that are mowed, fertilized lightly, and watered are more attractive. It will not grow in a shaded area.

The following chart provides information that should be useful in establishing the warm-season grasses:

Grass	Established from	Method of planting	Quantity per 1000 sq. ft.	Best planting season
Bermuda	Seed	Broadcast	½ to 1 lb.	Spring and early fall
	Sprigs	Sprig 6" apart in 12" rows	5 to 10 sq. ft. sod	
	Sod	Solid-lay as bricks	Same as area to be sodded	
St. Augustine	2" sod blocks or runners	2" blocks on 12" centers; runners planted on 12" centers	Sod blocks-30 sq. ft. of nursery sod Runners-3 to 6 sq. ft. of nursery sod	Spring and early summer
Buffalo	Treated seed	Broadcast	1/2 to 3/4 lb.	Spring
	4" sod blocks	On 1½ to 2 ft. centers	25 to 50 sq. ft. of nursery sod	

COOL-SEASON GRASSES

The higher altitudes in the state are the only areas where cool-season grasses can be used successfully as a lawn. Contrary to reports there is not a combination of cool and warm-season grasses that can be used for maintaining a year-around green lawn. Annual ryegrass has been used to overseed Bermuda, but excellent management is required for this to be successful. Ryegrass is very competitive; and if it is seeded over Bermuda, the Bermuda should be fertilized when it begins growth. The ryegrass must be clipped very close. Ryegrass should never be used to overseed other grasses.

Ryegrass

Most of the ryegrass seeds sold are a mixture of the perennial Lolium perenne and the annual Lolium multiflorum. Pure seeds of either, however, may be purchased. Under Texas conditions both species act as an annual except in the Panhandle where perennial ryegrass, under proper watering and care, may be used as a permanent lawn.

Ryegrass can be used successfully as winter protection before grass is established.

Tall Fescuegrass

The use of fescue as a lawn grass is questionable. It is often used as a substitute for ryegrass. There are two strains, Alta and Kentucky 31. In North and West Texas, they may provide a green turf throughout the year.

3. Vegetative Characteristics of Turfgrasses

Transparencies No. 1 and 2

Each grass has certain characteristics which can be used in its identification.

The grass plant can be divided into three principal parts: leaf, bud leaf, and stem.

The leaf is composed of the blade and the sheath. The blade is the upper part of the leaf that extends from the stem. The margin of the blade may either be serrated (saw-tooth edge) or smooth. The tip of the leaf blade will either be tapered, linear, or boot-shaped. The sheath is the lower part of the leaf that encloses the stem. Where the blade and sheath meet, one or more of three identifying characteristics may be found:

1. Collar-This is a thickened ridge on the underside of the leaf at the junction of the blade and sheath.
2. Ligule-The ligule is a curtain-like appendage on the top side of the leaf at the junction of the blade and sheath. The ligule may be brown in color and dried. Examples of ligules are shown.
3. Auricles-These are finger-like projections on each side of the leaf at the junction of the blade and sheath. Three types of auricles are shown in the illustration.

The bud leaf is the uppermost leaf on a stem. In the bud stage, the leaf is either rolled or folded in the bud.

The stem supports the leaves and is a long, hollow cylinder interrupted by joints (nodes). A specie of grass may or may not have rhizomes and stolons.

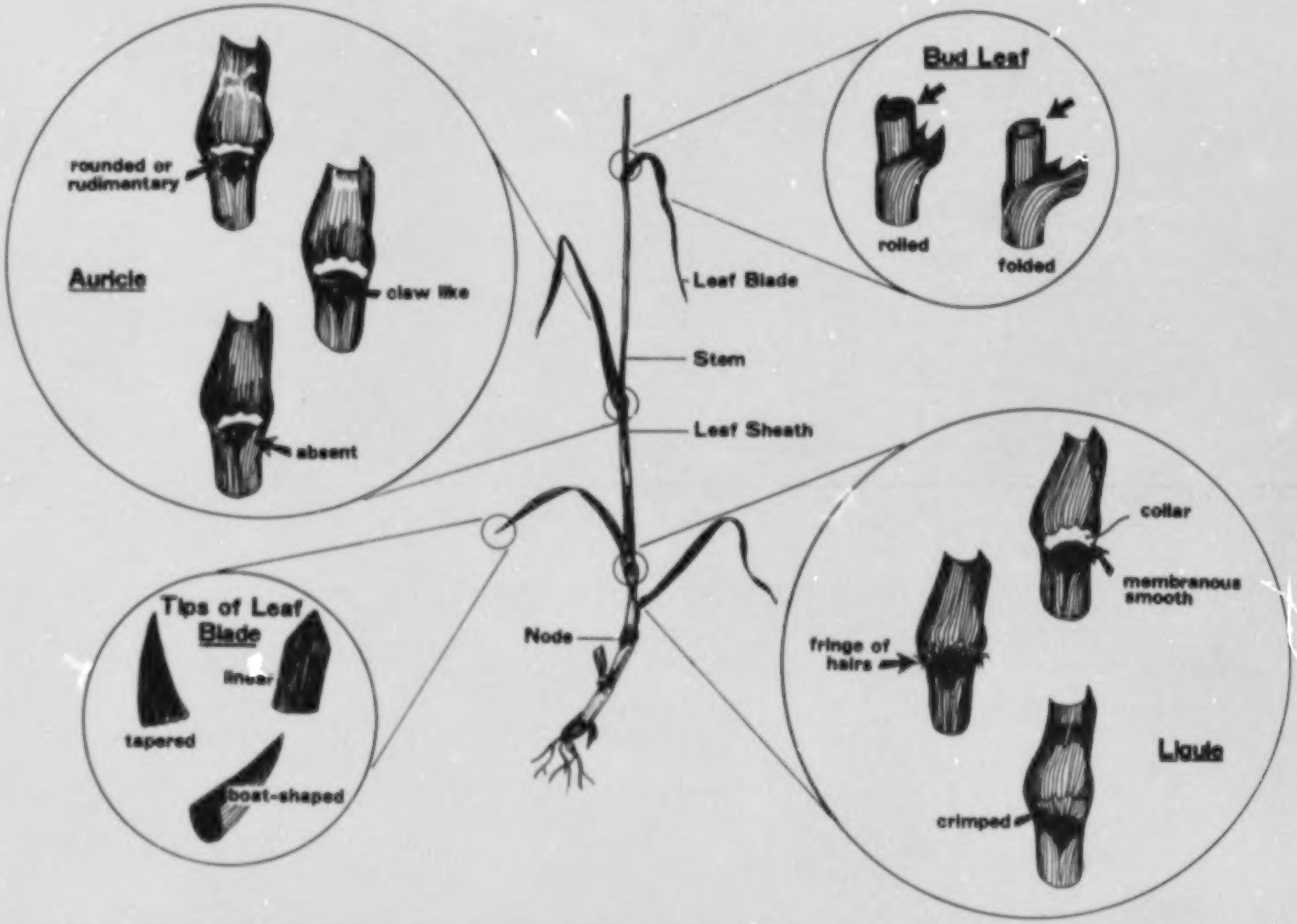
Rhizomes are stems growing underground. As they grow, roots are produced at the nodes; and new plants are produced.

Stolons (runners) are stems growing above the ground. When the stolon touches the ground, it roots at the node and produces a new plant.

Reference:

"Home Lawns", Texas Agricultural Extension Service Bulletin MP-1180.

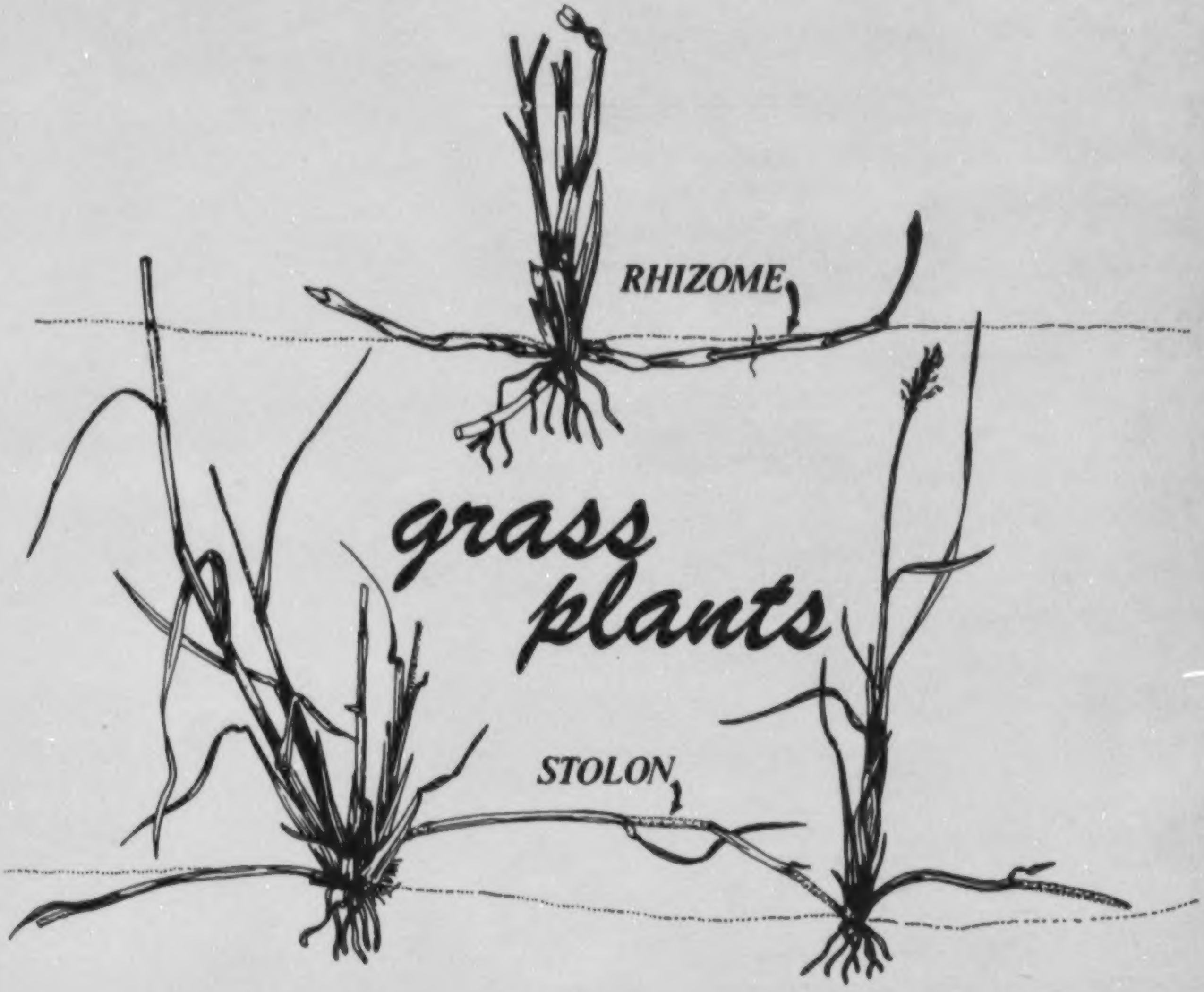
PARTS OF A GRASS PLANT


Auricle
rounded or rudimentary
claw like
absent
Bud Leaf
rolled
folded
Leaf Blade
Stem
Leaf Sheath
Node
Tips of Leaf Blade
tapered
linear
boat-shaped
collar
membranous smooth
fringe of hairs
Ligule
crimped

Pre-Lab, CVAE and VEH Horticulture

J-1
No. 1

grass plants


RHIZOME
STOLON

Pre-Lab, CVAE and VEH Horticulture

J-1
No. 2

Vocational Instructional Services
Agricultural Education

J-2
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit J: Establishing and Caring for Turf

Topic 2: Establishing a New Turf

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction

The area(s) of a landscape site on which turf will be established should be determined before construction begins. Also, other factors such as grading, drainage, irrigation, mulch, fertility, and materials should be determined at this time.

In order to have a good lawn, a number of preplanting steps must be considered and performed. There are no short cuts in the establishment of a good turf. Maintenance problems are reduced when adequate planning and careful preparations are made. Each step in the preparation of soils, seeding, and sodding are discussed.

2. Preparing the Soil for Planting

The soil is the foundation of the lawn. The lawn can be no better than its foundation. The ideal soil for growing grass is a sandy loam with a high organic content.

Transparency No. 1

The procedure to follow in preparing the soil for planting grass is as follows:

1. Topsoil is removed from site and stockpiled if grading is necessary to make the site level and to prevent low spots. The lawn grade should be 1 foot per 100 feet. The lawn should slope away from buildings, walks, and driveways. Retainer walls rather than terraces should be constructed on steeply sloped sites.
2. Subsoil is graded to proper grade. If it is necessary to dispose of some soil, the subsoil is disposed of. To get the proper grade, it may be necessary to drive stakes at intervals to indicate the amount of subsoil to be moved.
3. Irrigation lines, drainage lines, and utility lines are installed.

Transparency No. 2

4. Topsoil is placed over subsoil. Eight to twelve inches of topsoil are required to grow a good turf of grass. If it is necessary to add additional topsoil to a site it should be the same texture as the original topsoil. About one-half of the new topsoil should be mixed with the original. The remaining one-half of the topsoil is placed on top of the original topsoil. Trees, brush, lumber, concrete and other building residue should never be used as fill on a landscape site because it will create dry spots or drainage or settling problems.

5. If the topsoil is lacking in organic matter, it should be blended while the topsoil is being worked. A topsoil with sufficient organic matter will contain 50 percent solid matter and 50 percent pore space.
6. Fertilizer can also be mixed in with the topsoil or applied broadcast.

Transparency No. 3

7. Level and smooth bed. Several methods may be used. The method to use will depend upon the texture of the soil and equipment available.

3. Seeding the Lawn

Common Bermudagrass is the only turf grass recommended to be established by seeding. Seed of a high quality (high germination percentage and purity) should be used.

Transparency No. 4

Any of the methods shown in the above transparency may be used for seeding. Finely screened topsoil or sand is mixed with the Bermudagrass seeds to obtain an even distribution when using the hopper seeder-spreader or broadcast seeder. Seeds placed on top of the ground should be covered with about 1/8 inch of soil. This may be accomplished by dragging a chain harrow or fencing wire across the seedbed. After the area is seeded, the soil should be firmed around the seed by rolling. The newly seeded area should be watered with a fine mist. This will prevent the washing away of the seeds.

Mulching

Mulching the newly seeded lawn offers several advantages: (1) Mulch retains moisture and (2) It keeps the ground cooler in summer and warmer in winter.

Several kinds of materials are available for mulching. Straw or hay may be used if they do not contain weed seeds. The mulch is held in place by rolling it, or by spraying with a liquid latex. If too much mulch is applied, it may be necessary to remove some of it when the young plants attain a height of 1 to 1½ inches.

4. Planting a Lawn Vegetatively

The two methods used for the vegetative planting of grasses are sprigging and sodding. Sprigging is the setting of the plant stolons or rhizomes in rows. Sodding is the placing of squares or plugs of grass at intervals in the lawn.

Transparency No. 5

Sprigging

If adequate moisture is available, a lawn may be sprigged most anytime. The best time, however, is in the spring.

Small areas may be sprigged by digging small trenches parallel to each other and across the prepared bed. The runners are placed in the trenches, and the soil is firmed around them. The bed should be level after sprigging.

A large area may be sprigged by broadcasting the sprigs and covering them with a disk. If this method is used, the sprigs should be dug and covered with soil in a short period of time. Following the disking, the area is rolled to smooth the surface and firm the soil around the sprigs. From 40 to 80 bushels of sprigs are required per acre. The area should be thoroughly watered after being sprigged. Fertilizer should be applied before or after sprigging.

Sodding

When plugs are used, the area is lined with string, and a plug is placed in a small hole at specific intervals along the string. The spacing of the plugs will be determined by the rapidity in which one wants the area covered with turf.

The squares used for sodding are about 12 inches square. The squares are placed at intervals and are tapped lightly to firm the roots against the soil. A small amount of soil should be worked around the edges of the squares. The distance between squares depends upon the rapidity in which the area is to be covered with turf. The area should be kept moist until the sod is established.

Laboratory Exercise No. 1

Activity:
The seeding of a turf

Materials:
- Seeder (whirlwind seeder or hopper seeder-spreader, the seeds may be broadcast by hand)
- Seeds
- Prepared seedbed
- Mulching materials
- Sand (used in the hopper seeder-spreader)
- String-line (used with the hopper seeder-spreader)
- Stakes (used with the hopper seeder-spreader)
- Bucket or cloth sack (used to hold seeds)

Procedure:
1. The seedbed is prepared prior to seeding operation.
2. The procedure to follow is determined by the seeding method used. All three methods are explained below:
   a. Whirlwind seeder

(1) The rate of seeding is determined.
(2) The calibration on the seeder is set.
(3) The correct speed of travel and the proper speed of the seeder are demonstrated.
(4) The directions of travel are explained. One-half of the seeds should be distributed in one direction, and the other half should be distributed crosswise to the original direction.
(5) Seeds are distributed.
(6) Mulching material is placed over the seeded area. (It is assumed that the seedbed has been fertilized.)
(7) The mulching materials and seed bed are rolled.

b. Hopper seeder-spreader
  (1) The seeds are mixed with dry sand. The amounts of sand and seeds to include in the mixture are determined by the seeding rate and the calibration on the hopper seeder-spreader.
  (2) The calibration on the hopper seeder-spreader is set.
  (3) The rate of travel with the hopper seeder-spreader should be explained.
  (4) The prepared area is seeded. If it is impossible to determine the area covered with the seeder, a string-line may be used. One wheel of the hopper seeder-spreader is run along the line. After a through has been made, the string is moved the width of the spreader, and the wheel is run along the line in the opposite direction.
  (5) The mulching material is distributed. (It is assumed that the seedbed has been fertilized.)
  (6) The mulching materials and seedbed are rolled.
  (7) The seeded area is watered.

c. Broadcasting seeds by hand
  (1) The seeds should be divided into 2 equal parts. One-half will be broadcast in one direction, and the other half will be broadcast crosswise to the original direction.
  (2) The procedure to follow in broadcasting the seeds (hand motion and speed of travel) should be explained.
  (3) The seeds are broadcast. (If the seeds are going to be covered with soil, the seedbed should be dragged with a wire harrow.)
  (4) The mulching materials are distributed. (It is assumed that the seedbed has been fertilized.)
  (5) The mulching materials and seedbed are rolled.
  (6) The seeded area is watered.

Laboratory Exercise No. 2

Activity:
The sprigging or sodding of turf

Materials:

Sprigs	String line
Sod plugs and squares	Stakes

503

Procedure:

1. The seedbed should be prepared before beginning the sprigging or sodding.
2. The procedure to follow for sprigging and sodding is discussed below:
   - a. Sprigging
     - (1) Small trenches are dug in one direction in the seedbed. The distance between the trenches depends upon the rapidity in which one wishes the area to become covered with turf.
     - (2) The sprigs (stolons or rhizomes) are placed in the trench, and soil is firmed around the roots and nodes.
     - (3) The area may be rolled to level the seedbed.
     - (4) The area should be kept moist until it is covered with turf.
   - b. Sodding by Plugs
     - (1) Small holes are dug at intervals in the seedbed; a string-line may be used to maintain the proper distance and to keep the rows straight.
     - (2) The plugs are placed in the holes, and the plug is firmed to the soil. Soil should be firmed around the plugs.
     - (3) The area should be kept moist until it is covered with turf.
   - c. Sodding with sod squares
     - (1) The squares are placed at intervals on the seedbed.
     - (2) The squares are tapped lightly to firm the square with the soil.
     - (3) Soil should be placed around the squares and firmed.
     - (4) The area should be kept moist until it is covered with turf.

References:

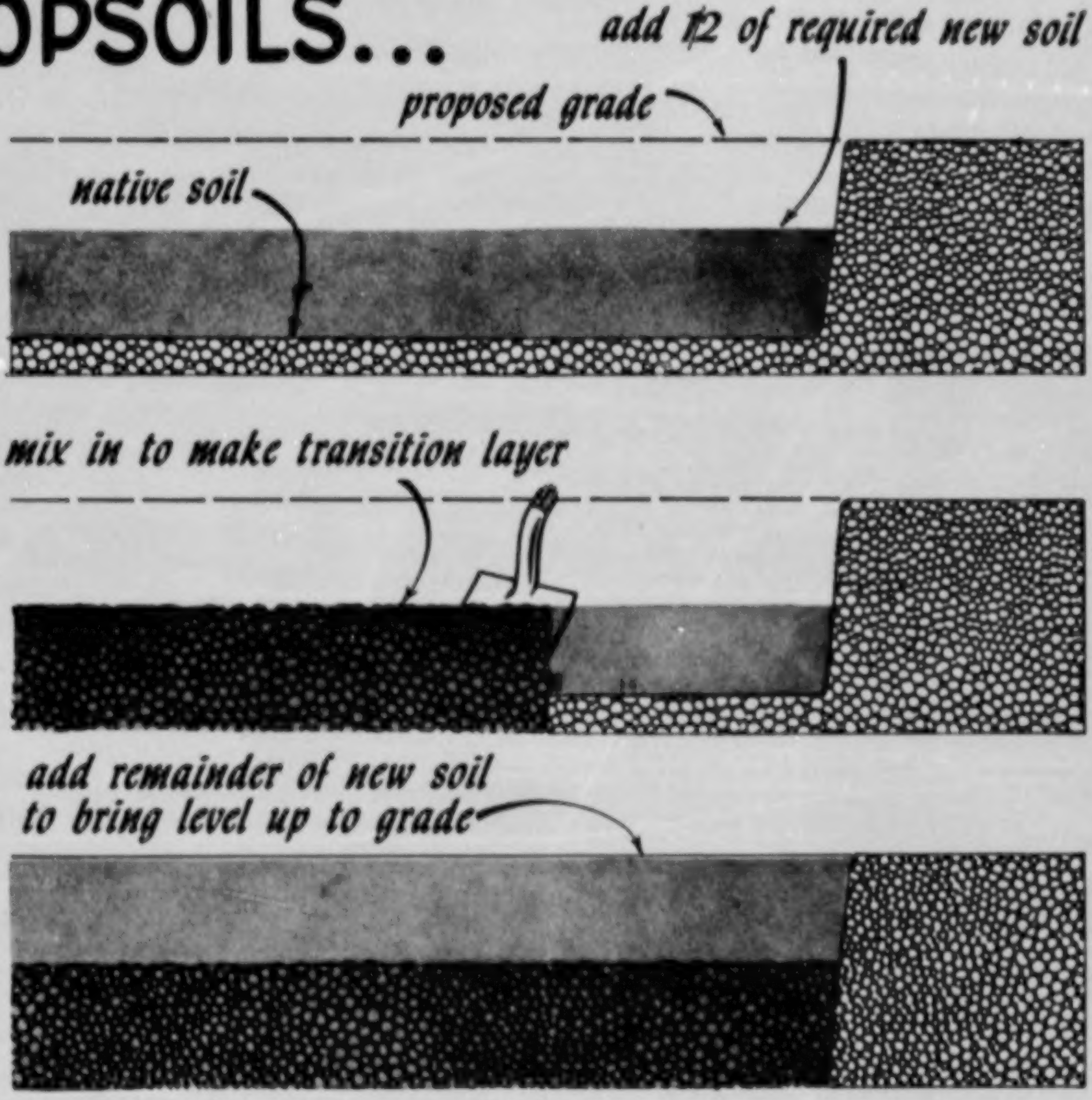
1. "Turfgrass Maintenance and Establishment," Volume 9, No. 4t, College of Agriculture, Pennsylvania State University.

2. "Home Lawns," Texas Agricultural Extension, B-203.

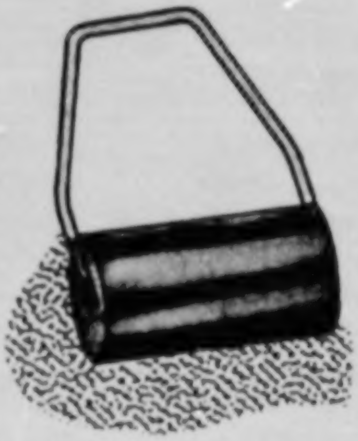
PROCEDURE TO FOLLOW IN PREPARING SOIL FOR PLANTING

- TOPSOIL IS REMOVED AND STOCKPILED
- SUBSOIL IS GRADED TO PROPER LEVEL
- IRRIGATION LINES, DRAINAGE LINES, AND UTILITY LINES ARE INSTALLED
- TOPSOIL IS PLACED OVER SUBSOIL
- ORGANIC MATTER IS BLENDED WITH TOPSOIL
- FERTILIZER IS APPLIED TO SEEDBED
- SEEDBED IS SMOOTHED AND LEVELED

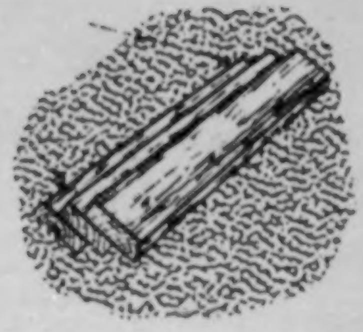
TOPSOILS...


add 1/2 of required new soil
proposed grade
native soil
mix in to make transition layer
add remainder of new soil
to bring level up to grade

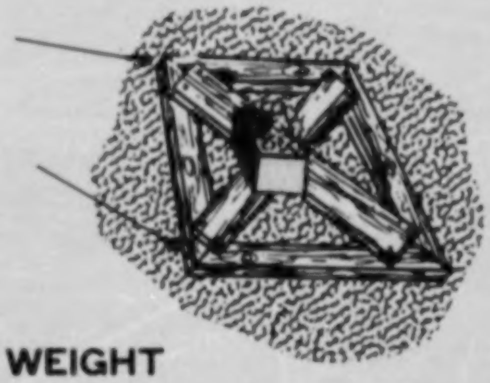
LEVELING AND SMOOTHING THE LAWN BED



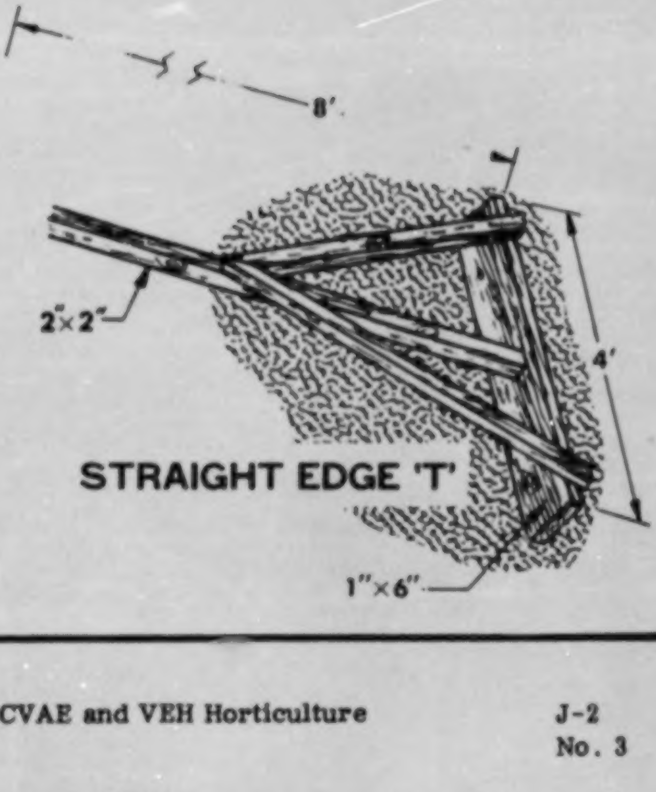
ROLLER



OVERLAPPING BOARDS

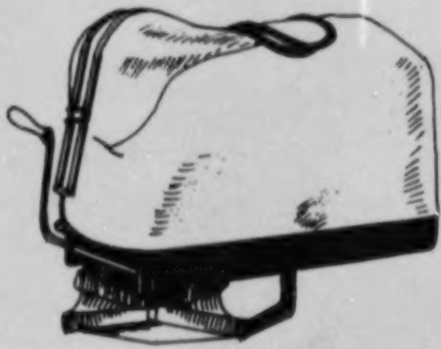


WEIGHT

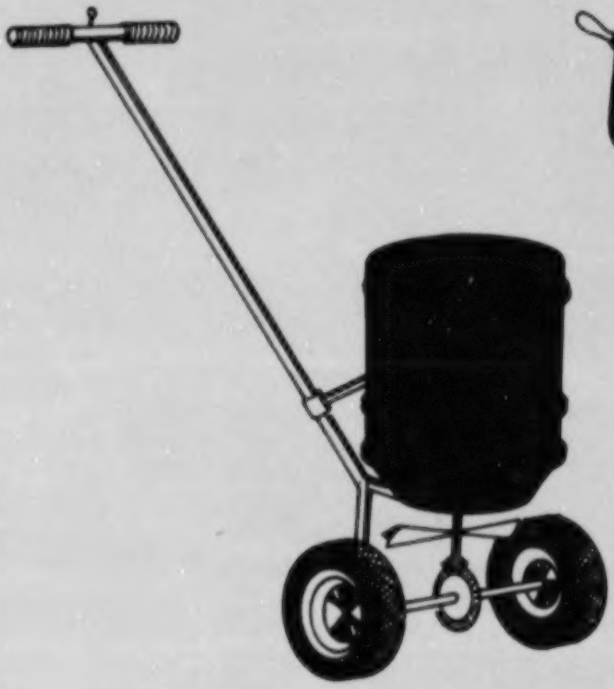


STRAIGHT EDGE 'T'

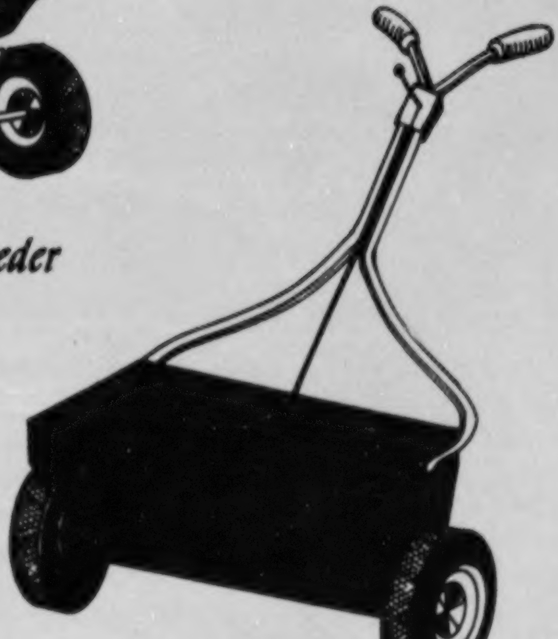
METHODS OF SEEDING



Whirl Wind Seeder



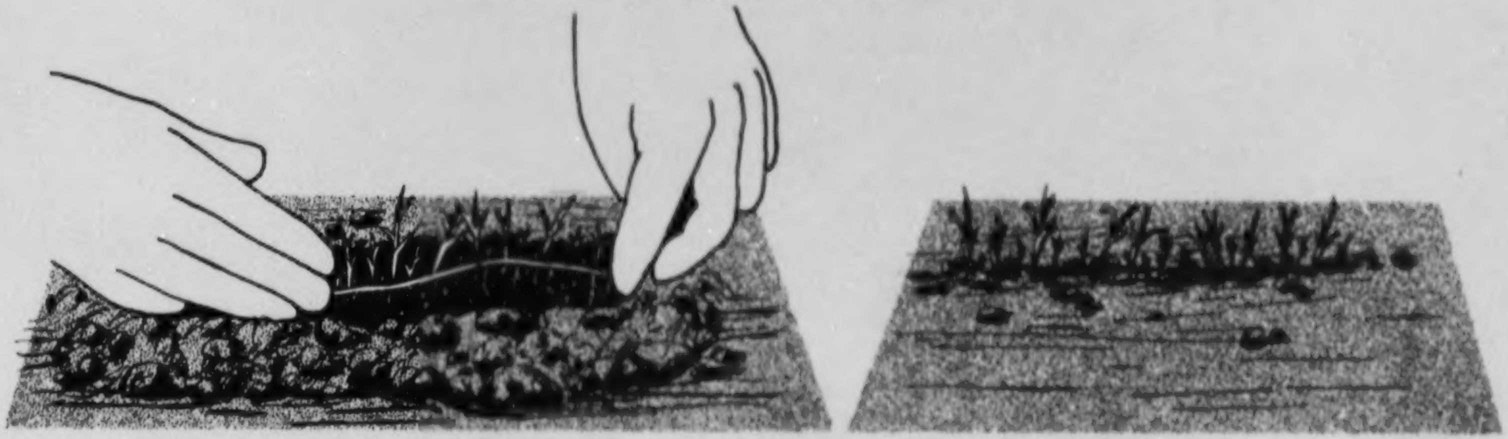
Broadcast Seeder



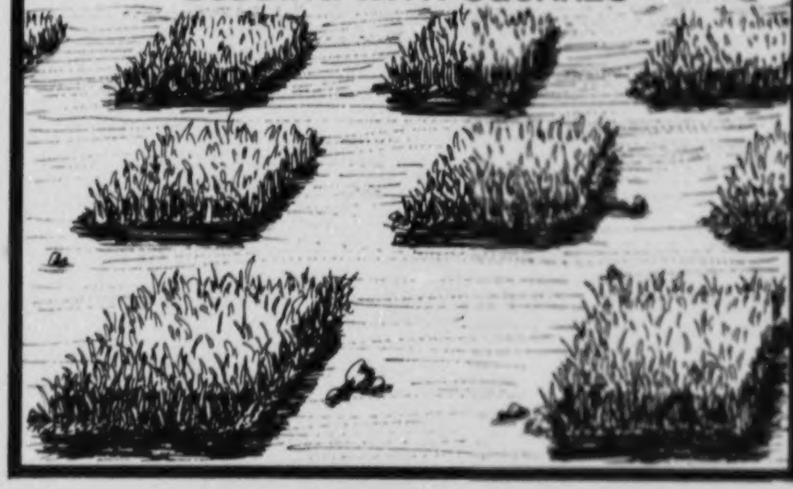
Hopper Seeder Spreader

Sprigging & Sodding Grasses

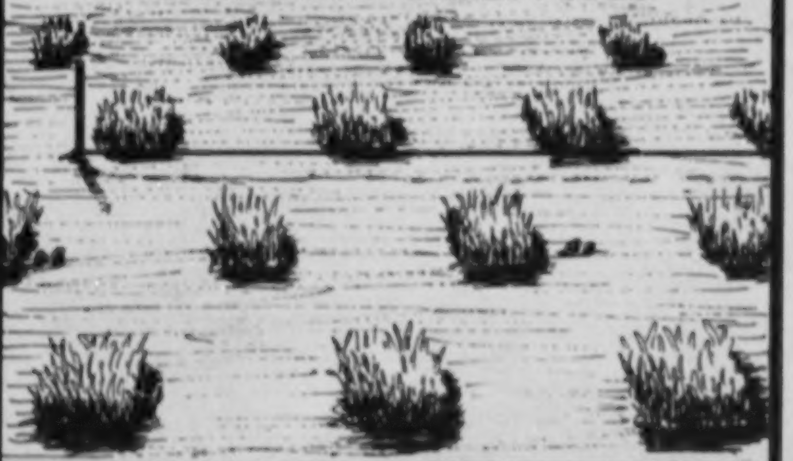
PLANTING STOLON IN TRENCH



SODDING WITH SQUARES



SODDING WITH SMALL PLUGS



CVAE AND VEH HORTICULTURE

Unit J: Establishing and Caring for Turf

Topic 3: Managing an Established Turf

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction

Four related factors are involved in the management of established turfs. These are feeding, watering, aerating, and mowing. All of these factors are of equal importance, and proper attention must be given to each to maintain a healthy, dense turf. The principles of good turf management apply to all types of lawns.

2. Feeding and Fertilizing Lawns

Since the grass clippings removed from a lawn contain a large amount of nutrients, lawns require a higher level of fertility than many other crops. Grasses display certain nutritional deficiencies with which the landscaper should become familiar and recognize. The most common nutritional deficiencies are as follows:

1. Leaves turn a yellowish or pale green color;
2. Grass becomes thin; and
3. Weeds begin to grow in the grass.

The three plant food elements needed in the largest quantity by grass are nitrogen, phosphorus, and potassium. Other elements are important to plant growth, but generally these elements are in sufficient quantities when there is an adequate supply of these three elements, which are called primary elements.

Deficiency symptoms of the three primary elements are as follows:

Nitrogen
1. Stunted growth
2. Small, thin yellow to yellowish-green leaves
3. Yellow to brown leaf tips and midribs

Phosphorus
1. Irregular brown patches on the leaves

Potassium
1. Leaves turn brown
2. Bronze colored spots sometimes develop on the leaves
3. Leaf tips appear scorched

The amount of fertilizer to apply should be based on a soil test.

Two other elements which can affect the growth of grass are calcium and iron. Plants need calcium for development of roots and cell walls. An inadequate supply of calcium will cause the leaves to become stiff and mottled. Calcium also neutralizes the soil, makes other elements more readily available, and improves soil structure. It is applied in the form of lime and in the same manner as fertilizer.

An iron deficiency is called chlorosis. It is more common in the south and western part of the state. Soils high in calcium prevent plants from assimilating iron, even though it is present in the soil. An application of iron chelate or iron sulfate (copperas) will usually correct this deficiency. The iron supplement may be applied to the soil in the dry form or by spraying. The most effective method of application is in the form of a spray. The recommended rate of application for spraying iron sulfate is 3 ounces per 5 gallons of water. A detergent should be added to the spray to assure good leaf coverage. When using the dry form of iron sulfate, the recommended rate is 10 pounds per 1,000 square feet. Follow manufacturer's recommendation when applying iron chelate.

Time to Fertilize

Turf grasses should be fertilized in the spring and fall. The spring application should be about the time the grass begins to grow. The fall application should be applied about 30 days prior to the first killing frost. An application of a nitrogen fertilizer between the spring and fall application will encourage growth of the above ground portion of grasses.

Types of Fertilizers

Organic and inorganic are the two types of fertilizers that may be used. Organic fertilizers decompose more slowly and are reported to be more desirable when they are available. However, they usually cost more. Inorganic fertilizers should be applied in smaller amounts and more frequently, as they are more likely to burn the grass. There are a number of different types and grades of fertilizers that may be used.

Factors that should be considered in selecting the type and grade are availability, price, and ease of handling. The following table shows the two types of fertilizers, their analysis, the recommended rate of each, and the frequency of application:

Material	Percent N	Percent P_2O_5	Percent K_2O	Amount to apply per 1,000 sq. ft.	Frequency of application
Organic					
Cottonseed meal	6	2	TR	15 lb.	Every 40 to 50 days

Material	N	Percent P_2O_5	K_2O	Amount to apply per 1,000 sq. ft.	Frequency of application
Processed sewage sludge					
Milorganite	6	3	0	15 lb.	Every 40 to 60 days
Hou-actinite	6	3	0	15 lb.	Every 40 to 60 days
Inorganic					
Ammonium nitrate	33.5	0	0	3 lb.	Every 30 days
Ammonium sulfate	21	0	0	5 lb.	Every 30 days
Nitrate of soda	16	0	0	6 lb.	Every 30 days
Urea compounds					
Urea	45	0	0	2 lb.	Every 30 days
Urea formaldehyde	38	0	0	2 lb.	Every 40 to 60 days

The urea forms of fertilizer shown above are synthetic compounds which are similar to organic fertilizers in their decomposition. These compounds are broken down in stages by the soil microorganisms. As a part of the compound decomposes, another part becomes available for decomposition. This procedure continues until the compound is completely broken down. Since a relatively longer period is required for decomposition, the urea forms of fertilizers may be applied less frequently.

It is a common practice for some home owners to topdress their lawns each year in the spring with topsoil. They are of the opinion that a good topsoil with a high organic content will provide an adequate supply of nutrients. An application of good topsoil will possibly provide the nutrients needed for good grass growth, but it is not recommended. The repeated application of topsoil to the lawn causes alternate layers of soil and stems. This increases maintenance requirements and the possibility of insects and diseases attacking the lawn. The application of a topdressing of manure to the lawn is also not recommended because manure usually contains weed seeds.

Before using a fertilizer distributor or spreader, the calibration should be checked for accuracy. This may be accomplished by spreading a large sheet of wrapping paper or plastic on a firm, smooth surface and making a pass with the loaded distributor on the sheet. The fertilizer is then collected from the sheet and weighed. The following formula is used to determine the rate in pounds distributed per 1,000 square feet:

$$\frac{\text{Pounds Collected}}{\text{Sq. Ft. Covered}} \times 1{,}000 = \text{Rate per 1,000 sq. ft.}$$

For example, a 2-feet wide hopper seeder-spreader which distributes 1 pound of fertilizer in a 10 feet pass would apply fertilizer at the rate of 50 pounds per 1,000 square feet (1/20 X 1,000 = 50 lbs. / 1,000 sq. ft.).

3. Watering Lawns

Watering is the lawn maintenance practice most often incorrectly performed. The turf should never be watered until the grass shows signs of needing moisture. Grass indicates its need for moisture by a wilting and curling of its leaves. The leaves also will become dry and produce a dull brown color. These signs normally will appear first in small areas in the lawn. As the need for moisture becomes more critical, the size of the drier areas will increase. It is not uncommon for the same areas in the lawn to always be the first to indicate a moisture deficiency.

When lawns are watered, they should be thoroughly soaked to a depth of 6 inches. The meeting of the topsoil and subsoil moisture is ideal. Deep watering encourages root development and a larger root system. A larger root system more efficiently utilizes soil nutrients.

The light sprinkling of lawns is never recommended except during excessively hot periods following a prolonged period of heavy rainfall. Light sprinkling during this period will reduce the scalding of the grass. Light sprinkling causes the plants to produce shallow, weak root systems which are unable to utilize enough nutrients or moisture to maintain a healthy condition. It also encourages weed growth and the spread of disease.

Turf grasses should be watered during dry periods in the winter, as well as in the summer. The roots of the grass are still alive during the winter and need an adequate supply of moisture.

Amount and Frequency of Watering

The three factors affecting the amount and frequency of watering are soil type, kind of grass used in the turf, and climatic conditions.

The soil type determines the quantity of water that can be held in the soil and the rate of absorption (permeability). Grasses growing on sandy soils should be watered more frequently than grasses growing on loam or clay soils. Sandy soils absorb water more rapidly and use it more rapidly.

Different grasses have different water requirements. St. Augustinegrass has a higher water requirement than Bermuda, and Bermuda requires more water than Buffalo.

Time and Rate of Watering

In areas where grasses are affected with disease, the best time to water is in the morning, or at a time that will allow the grass to dry before the evening darkness. Watering at night decreases the quantity of water needed, but it also increases the humidity. The plants are damper for a longer period of time. Prolonged dampness encourages diseases.

Transparency No. 1

The rate and quantity of water applied can be measured by placing empty tin cans under the sprinkler. Several rows of cans should be placed from one edge of the sprinkler pattern to the other edge. The water in the cans should be measured in a specific period of time. The cans in different locations will probably catch different amounts of water, but this will help one determine the length of time the sprinkler is to run in one location, the amount of overlap necessary when locating sprinklers, and the wetting pattern of the sprinkler being used. The above test for rate and quantity is accurate only if the same amount of pressure is used as was used in the test.

A knowledge of the wetting pattern produced by different sprinklers is important in the watering of lawns. The kind of wetting pattern produced is affected by the amount of wind and the type of sprinkler used. A number of different kinds of sprinklers are available.

Transparency No. 2

One of the most commonly used sprinklers (Ill. No. 1) has two horizontal arms and revolves slowly. Water is propelled through jets at the ends of the arms. The wetting pattern is erratic, and the water is not distributed evenly. A similar type sprinkler is available and used for underground watering systems. The sprinklers must be positioned so that the wetting pattern will overlap if an even distribution of water is desired.

The sprinkler shown in Illustration No. 2 throws water in a circle. It does not produce an even distribution of water, and the wetting patterns must be overlapped to water the grass uniformly. Since this sprinkler produces a fine mist, water evaporation is greater than for some other types of sprinklers. This type also is used for permanent underground watering systems.

In illustration No. 3 is an oscillating sprinkler which has a single horizontal arm that moves and produces a square or rectangular wetting pattern. A large amount of water is distributed near the sprinkler, and the amount diminishes to the outer edge of the wetting pattern. This type of sprinkler is very good where several sprinklers are positioned for overlapping watering patterns. The arm is adjustable, and the sprinkler is calibrated for different sized rectangles. It also can be set to spray in only one direction.

4. Aerating a Lawn

In areas of the lawn that are subject to wear, compaction of the soil may become a problem. Fine textured soils are more susceptible to compaction than coarse textured soils. This condition may be corrected by aerating the soil. Aeration loosens the soil, allows the movement of moisture and oxygen within the soil, increases the water holding capacity of the soil, and encourages root growth.

Transparency No. 3

A number of different kinds of aerators are available. The size of the area to be aerated will influence the aerator selected. The foot operated aerator may be used for small areas, while power operated aerators may be more efficient on larger areas. The aerator should remove a small plug of soil from ¼ to ½ inch in diameter and from 2 to 4 inches deep.

Areas that are severely compacted should be watered slowly prior to using the aerator. However, the soil must be dry enough for the aerator to remove the soil cores. Three or four passes should be made in different directions across the lawn.

The holes left in the lawn after aeration may either be filled with soil or sand, or may be left open to be filled with the roots of the growing plant. The filling of the holes with sand should improve the condition of the soil. The core plugs may be left to disintegrate on the lawn, or they may be broken by dragging a metal mat across the lawn.

The lawn may be aerated in the spring or fall, but the grass should be growing rapidly.

5. Mowing the Lawn

Proper mowing improves the drouth resistance of the plants and prevents weeds and diseases. The most important management decision pertaining to mowing is the height to mow. Mowing too close thins the turf, lowers the resistance of the grass to drouth and diseases, and encourages shallowrooting of the grass and the invasion of weeds. It also will cause excessive drying and baking of the soil and heat damage to the grass.

The leaves of grass manufacture the food for the plant and produce the green color. The plants suffer when too much of the leaf is removed at one time. The proper height for Bermudagrass after mowing is 1 to 1½ inches, and no nore than 1½ inches should be clipped from the plant. St. Augustinegrass should be mowed to a height of 1½ to 2 inches. No more than 1½ inches of leaf should be clipped at a mowing from St. Augustinegrass.

The growth of the grass will determine when it should be mowed. In the spring, it may be necessary to mow every 4 or 5 days; while during the slower growing period of mid-summer, mowing every 7 to 10 days may be sufficient. Grass should be mowed when the grass exceeds the mowing height by 1 to 1½ inches.

If the grass is mowed at the proper height, the clippings may be left on the lawn to decay and to return some nutrients to the soil. If there is a buildup of clippings after the lawn is mowed, they should be removed. Some mowers have attachments that will catch the clippings while the lawn is being mowed.

Mowing grass too high also can present problems. The continued mowing of some strains of Bermuda and St. Augustinegrass too high will cause a thatch buildup, a buildup of stems and leaves. The thatch acts as insulation, and new grass roots must penetrate the thatch to get to the soil. Also, a thatch buildup encourages the spread of disease.

Mowing Practices

Mowing the lawn in the same direction each time will cause a streaked or banded appearance called "grain." This can prevented by mowing in a different direction each time the lawn is mowed.

The grass should be dry when it is mowed. Mowing while wet tends to tear and bruise the grass, and the leaves will stick together and form clumps. These clumps must be removed to eliminate a disease and insect hazard and to prevent an unsightly appearance.

Lawn Mowers

Transparency No. 4

Both reel and rotary mowers offer certain advantages. Reel mowers are less dangerous and are less likely to scalp the turf. However, the lawn must be level and free of foreign objects. Reel mowers are available in both hand and power models and may be purchased with 4 to 12 blades. The more blades a reel mower has, the closer and smoother the grass can be cut. The 12-blade reel mowers are used for cutting the grass on putting greens.

The rotary mower will make a smooth, even cut on a level lawn. A rotary mower is likely to scalp the turf on an uneven lawn. The turning blade on a rotary mower has a great amount of force and can throw objects a long distance. It is the more dangerous of the two types. The rotary mower can mow much taller grass and weeds than the reel type. The blades of both types should be sharp to obtain maximum performance.

Laboratory Exercise

Activity:

Checking the calibration of a hopper seeder-spreader for accuracy

Materials:

Hopper seeder-spreader
Fertilizer
Sheet of paper or plastic (The paper or plastic should be wide enough to prevent the loss of fertilizer when it is distributed on the sheet.)

Procedure:

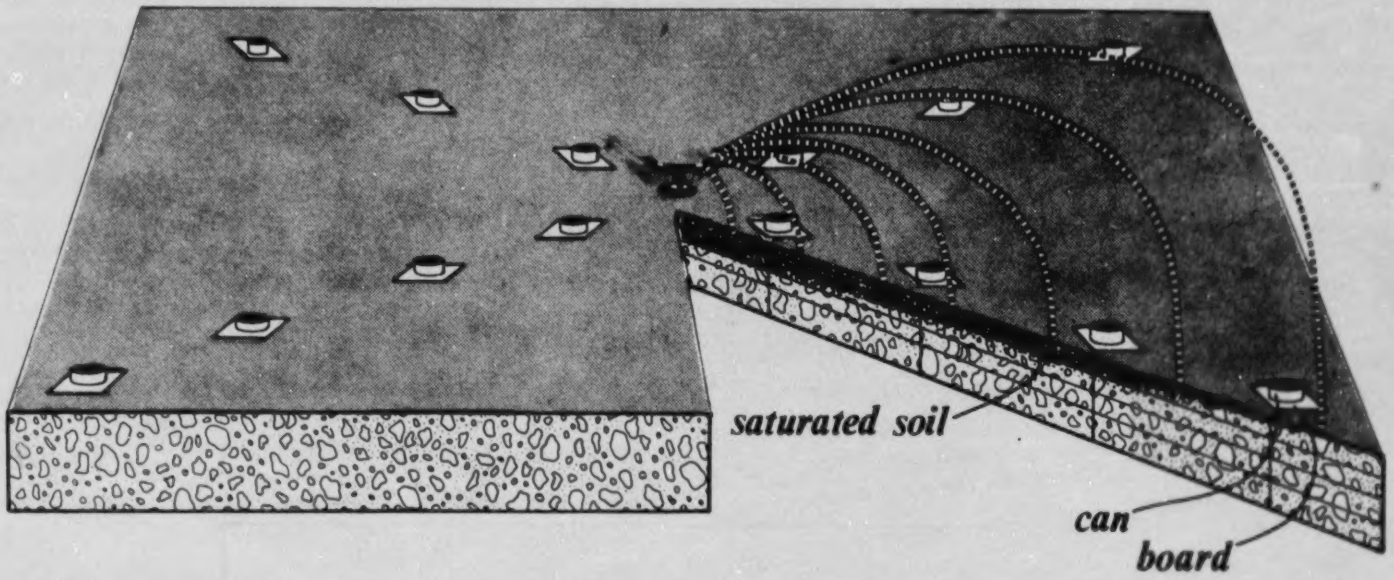
1. The calibration on the spreader is set.
2. The spreader is filled with fertilizer.
3. The sheet of paper or plastic is rolled out on a smooth, firm surface and held in place. A sidewalk or driveway makes an ideal surface on which to roll out the sheet.
4. A through of fertilizer is distributed on the sheet, and the length of the through and the width of the spreader are measured. The number of square feet covered by the spreader is determined.
5. The distributed fertilizer is collected and weighed.
6. The formula, $\frac{\text{pounds collected}}{\text{sq. ft. covered}} \times 1{,}000$, is used to determine the rate of fertilizer applied per 1,000 sq. ft. at the preset calibration on the distributor. Other calibration settings may be determined in the same manner.

References:

1. "Turfgrass Maintenance and Establishment," Vol. 9, No. 4t, College of Agriculture, Pennsylvania State University, University Park, PA.

2. "Lawns and Ground Covers," Lane Books, Menlo Park, CA.

Measuring Quantity and Rate of Water Distribution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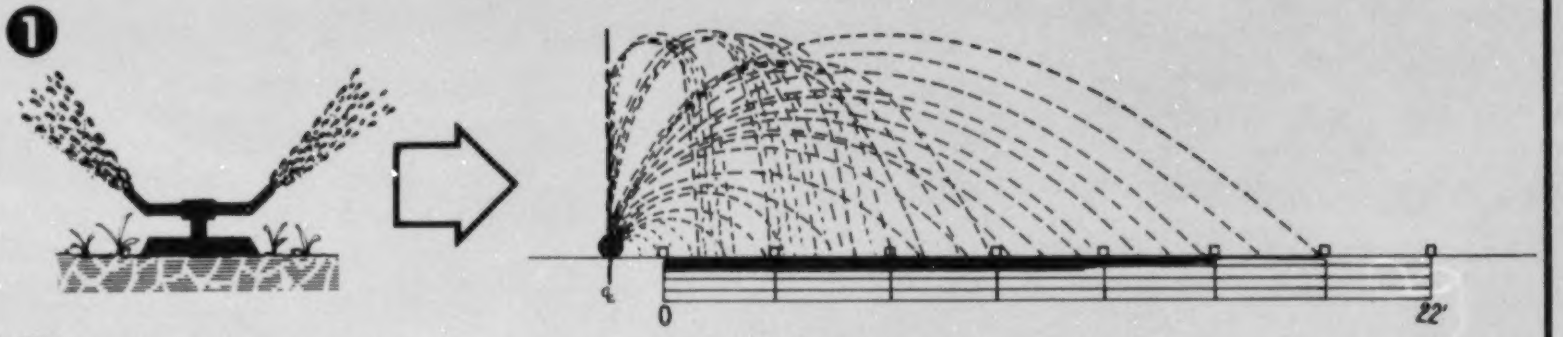

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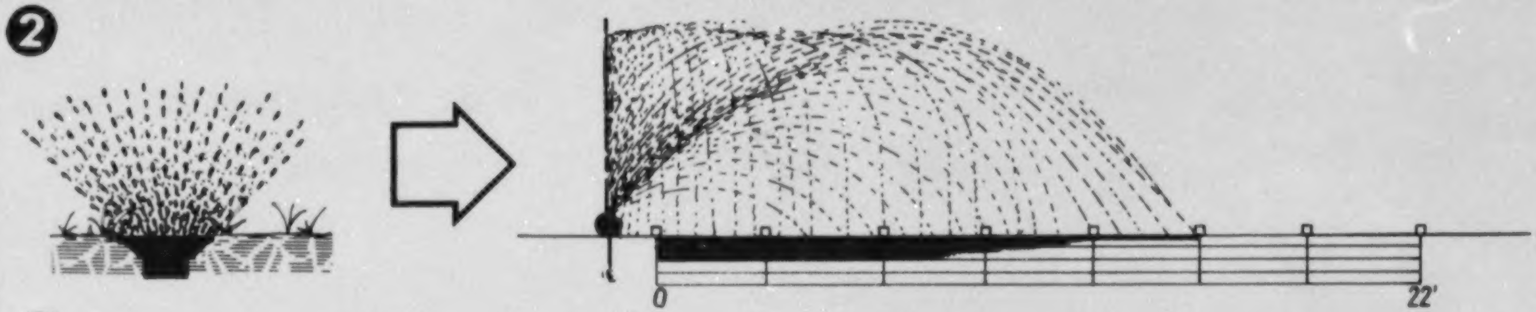

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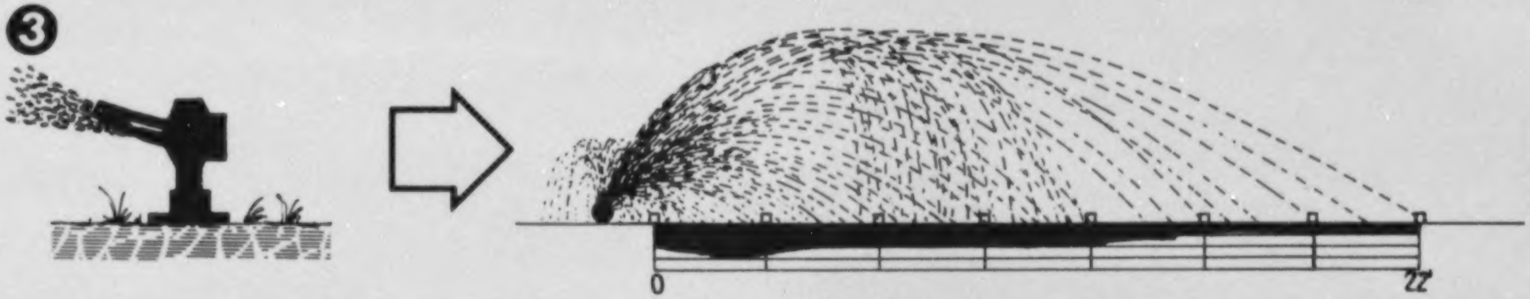
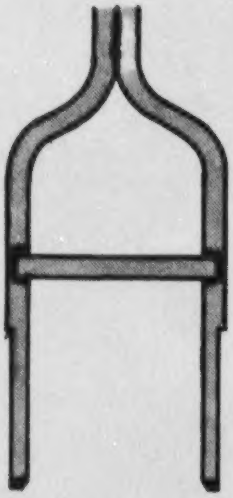
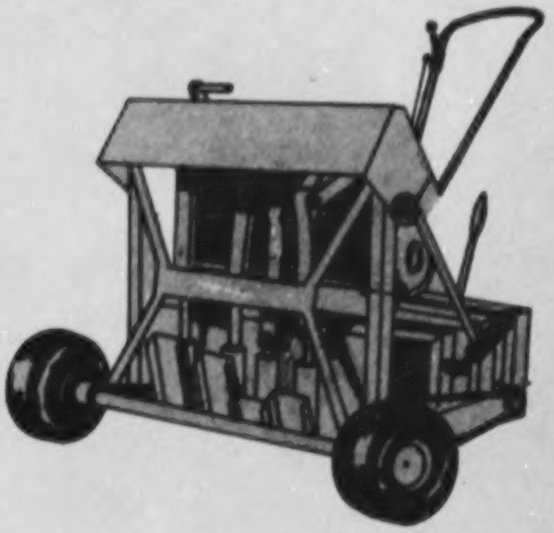


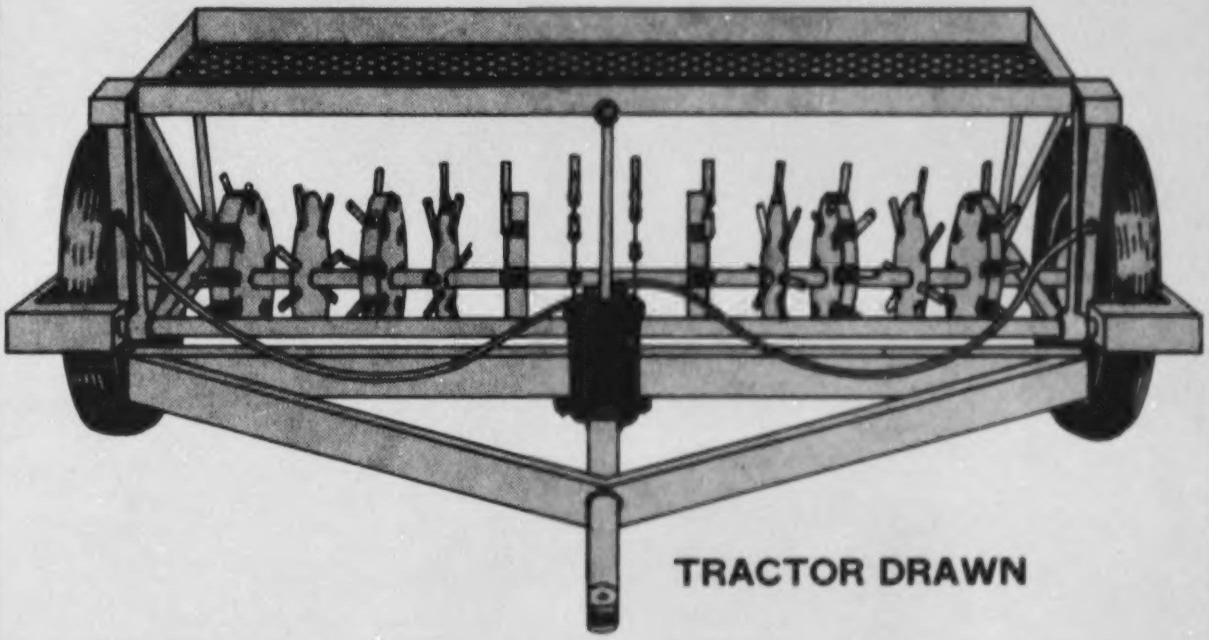
AERATORS



FOOT OPERATED AERATOR



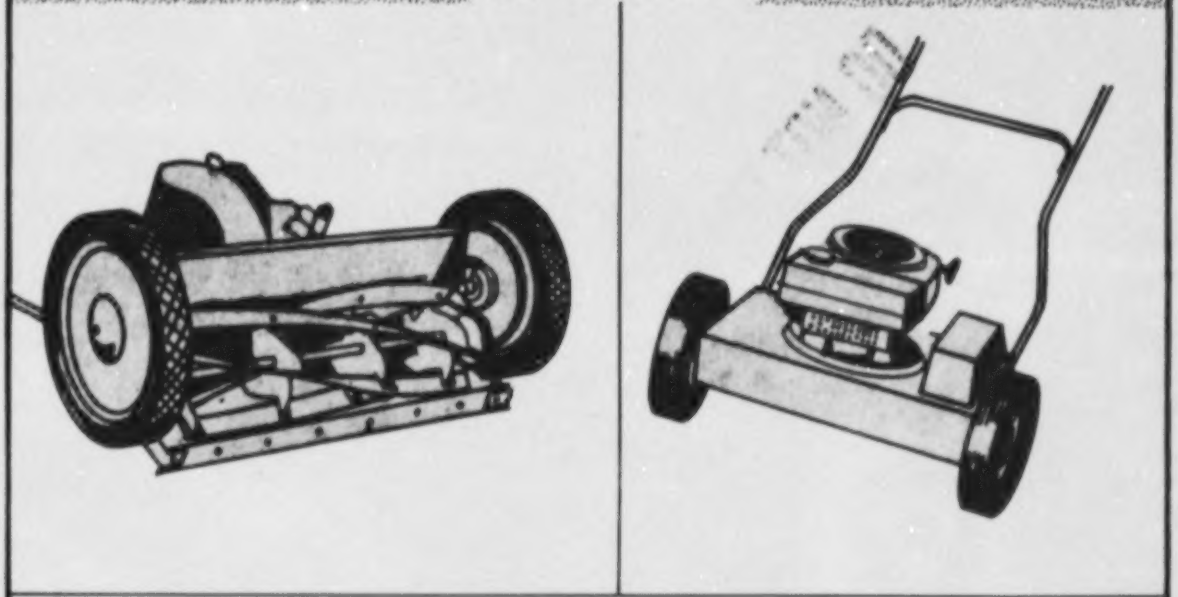
POWER AERATOR



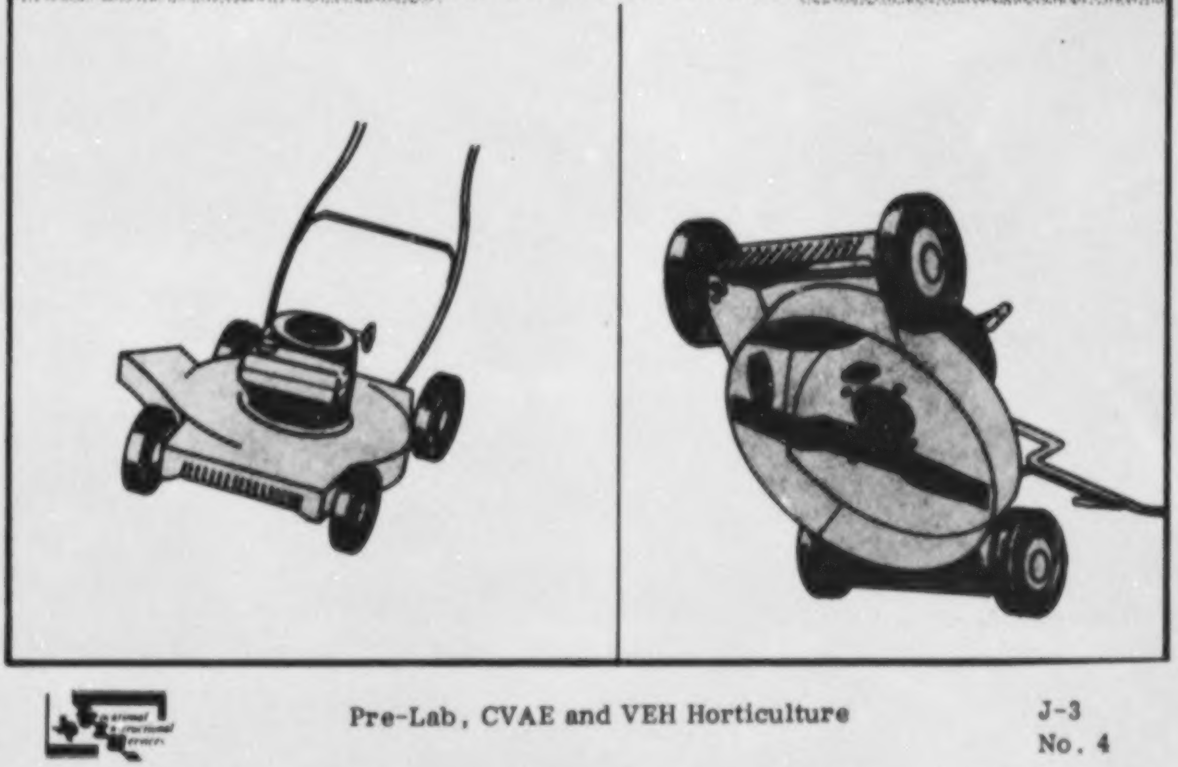
TRACTOR DRAWN

REEL AND ROTARY MOWERS

REEL MOWER



ROTARY MOWER



CVAE AND VEH HORTICULTURE

Unit J: Establishing and Caring for Turf

Topic 4: Turf Problems

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

It is suggested that the teacher demonstrate several methods of weed, insect, and disease controls.

1. The Control of Weeds in Lawns

Weeds rarely present a problem in well-established, properly managed lawns. The appearance of weeds is an indication of improper lawn management. Vigorous growing lawn grasses will choke out weeds and produce a dense turf. The landscaper should be aware that the killing of weeds in a lawn is only one of many good management practices.

Weed Classification

Weeds may be grouped into three classifications based on methods of control. These are as follows:

1. On the basis of their general structure. There are two groups based on structure: (1) grass type weeds, and (2) broadleaf weeds. Grass type weeds are those with characteristics similar to grass. Broadleaf weeds are those that are not like grass. The term broadleaf does not mean that the leaf will have a broad dimension.
2. On the basis of environment. These groups are field weeds, pasture weeds, lawn weeds, aquatic or water weeds, etc.
3. On the basis of habit of growth or life cycle. Using the habit of growth as a basis of classification, the groups are annuals (true annuals and winter annuals), biennials, and perennials (simple perennials and creeping perennials).

A knowledge of the life cycle of weeds is helpful in controlling them. Annuals are reproduced and begin their growth from seeds. Biennials live for two growing seasons, and new growth in the second year is produced from the crown of the plant. Biennials usually do not produce seeds until their second year of growth. Perennial weeds live for an indefinite period and produce new growth from their vegetative parts, which may be rhizomes, stolons, crowns, and bulbs. They also may reproduce from seeds.

Annual weeds may be controlled by preventing them from seeding. However, it is possible for the seeds to live a number of years in the soil. Biennials may be controlled by the same means.

There are three types of perennials, which are simple, bulbous, and creeping. Simple perennials reproduce from seeds, while the bulbous type reproduces from bulbs and bulblets. Some weeds in this group produce aerial bulblets, while others produce underground bulbs. The most effective means of controlling weeds in this group is by the application of a herbicide.

Creeping perennials spread and reproduce from stolons, rhizomes, and seeds. The most effective means of controlling them is with a herbicide.

Crabgrass, goosegrass, sandburr, and dallisgrass are the principal grassy weeds causing problems during the summer. The first three are annuals; they emerge from seed each spring. Dallisgrass is a perennial grass that recovers from rhizomes in the spring. It also produces seed that spread throughout the lawn.

Cool season grasses often causing problems in the lawn are rescuegrass, annual bluegrass, and ryegrass. These can be controlled by applying a preemergent herbicide in the early spring.

Broadleaf weeds sometimes posing a problem are dandelion, chickweed, henbit, clover, dock, and mustards. These may be controlled with a selective postemergent herbicide. Nutgrass creates a special problem in some lawns because it grows very rapidly and reproduces from bulbs. St. Augustinegrass when healthy can compete with nutgrass.

Time to Apply Chemicals

The best time to apply chemicals to weeds is while they are growing rapidly and before they produce seeds. A chemical treatment is not as effective when the plant is growing slowly and nearing maturity. The stage of growth at the time the chemical is applied is very important in obtaining a good kill of the weeds.

The chemical should be applied to upright and creeping weeds before they reach a height of 4 inches. If they are taller, the weeds should be mowed and allowed to grow 3 or 4 days before the chemical is applied.

Kinds of Herbicides

Herbicides are classified according to the method in which they kill the weed. The two types are contact and translocated. Contact herbicides kill the plant on contact. The herbicide of the translocated type is transferred from one part of the plant to the rest of the plant through the vascular system.

Petroleum oils, dinitrophenol acids, and salt solutions such as sodium arsenite and sodium chlorate are examples of contact herbicides. Examples of translocated herbicides are 2, 4 D and 2, 4, 5 T.

Herbicides are also classified as selective and nonselective. A selective herbicide will kill certain kinds of weeds while inflicting very little or no damage to the other growing plants. Nonselective herbicides will kill all of the plants which it comes in contact with.

Forms of Herbicides

Both selective and nonselective herbicides may be applied as sprays, dusts, or granules. The spray and dust forms are applied to the above ground portion of the plant, while the granular form comes in contact with the plant roots. The granular form is often mixed and applied with fertilizer.

Chemicals Used to Kill Broad-leafed Weeds

The hormone types, such as 2, 4 D; 2,4,5, T; and 2,4,5 TP, are the most commonly used for killing broad-leafed weeds. They kill the weeds by stimulating their growth to the extent that the weeds die. The chemical compound is absorbed by the plant and carried to all of the parts of the plant through the vascular system. The entire plant is killed by the chemical. A period of time may be required before the plants die.

The above listed herbicides cannot be purchased or applied without being a licenced applicator. Also, in order to purchase and apply many insecticides and fungicides requires a license.

Application Equipment

A number of different kinds of equipment can be used in the application of herbicides. The size of the area to be treated, method of treatment, type of herbicide to be used, and equipment available are some of the factors that should be considered.

When only a small area (spot treatment) within the lawn is to be treated, a triggertype squirting oil can, paint brush, squeeze bottle, or a water pistol can be used to apply the herbicides.

A hose-on applicator, pressure tank sprayer, or fertilizer spreader may be used to treat larger areas. Once a pressure tank has been filled with a herbicide, it should not be used for any other purpose, since it is practically impossible to rinse all of the herbicide from the tank and hoses.

2. Lawn Diseases

Lawns are susceptible to a number of diseases; however, properly managed lawns are less susceptible and will recover much quicker from a disease attack. Fungus diseases are the ones that most often attack lawns, and they are the most difficult to identify. When management practices are being properly applied and the possibility that the damage is caused by insects can be eliminated, then usually a fungus disease is responsible for the problem. Seldom will a fungus disease show symptoms which will aid in its positive identification. However, a landscaper should be familiar with the symptoms of the different fungus diseases.

Brown Patch

This disease affects Bermuda and St. Augustinegrass lawns in late spring and early fall. The disease occurs as irregular shaped brown areas, which usually are circular in shape and from 4 to 48 inches in diameter. Since the fungus is active on the outer surface of the affected area, the grass in this area has a blue, water-soaked appearance. The ring is often referred to as a smoke ring. The circular shaped areas may run together on severely infested lawns.

Helminthosporium Leaf Spot (Root Rot of Bermuda)

This disease produces irregular patches of infested areas 2 to several feet in diameter. The leaves of infected plants will have small, olive green spots which will increase in size and turn into dark blotches. The leaves eventually die and turn a light tan color. The fungus overwinters in thatch at the base of the plant.

Gray Leaf Spot

This disease affects St. Augustinegrass by producing brown to gray spots on the leaf blade. Lesions may be found on the stems and spikes of affected plants. Moisture and a warm temperature favor the development of the disease, and it usually appears in areas that are shaded. The grass will often appear burned or scorched.

Fairy Ring

This disease received its name from the semi-circle or circle of mushrooms growing in the area. The circular effect is caused by the development of organic matter and the production of fruiting structures produced by the fungus. The grass is often greener in the ring area because of the nutrients liberated by the decomposition of the fungus.

Rust

Rust is most active during mild, warm weather. Plants have a chlorotic appearance, and the grass becomes thin. The leaf blades develop orange colored pustules or raised bumps. The bumps are difficult to see.

The above fungus diseases and methods of control are listed in the following chart:

Chemical	Trade name and formulations	Brown Patch	Helminthosporium	Gray Leaf Spot	Fairy Ring	Rust
PCNB	Terraclor (L, G, WP)	x				
Maneb	Dithane M-22 (WP) Mansate (WP)		x	x		x
Maneb and co-ordinated zinc ion	FORE Dithane M-45 (WP)	x	x	x		x
Zineb	Dithane Z-78 (WP) Parzate (WP)		x	x		x
Thiram	Thylate (WP)					
Captan	(WP)			x		
Cycloheximide + PCNB	Acti-dione RZ (WP)	x				x
Mercuries	(All) (L)	x	x		x	
Daconil	One (WP)		x	x		
Dyrene	(WP)		x	x		

The above information was taken from Texas Agricultural Extension publication, "Control Disease in the Home Lawn," L-732.

3. Lawn Insects

Lawn insects can be divided into two groups, those that feed on the above ground portion of the plant and those that feed below ground. The following chart lists the insects in each group, identifying characteristics, and methods of control:

Insects	Description and type of damage	Treatment (Listed alphabetically) (Follow manufacturer's directions for mixing and applying sprays)		Remarks
		Dust:	Sprays:	
White grubs (larvae of May bettles)	White with brown head and 6 legs. One to 1½ in. long. Grubs feed upon roots and underground tender parts of plants.	Wettable powders-6 oz. of 25% Aldrin; or 10 oz. 40% Chlordane; or 4 oz. 25% Dieldrin; or 5 oz. 25% Heptachlor per 1,000 sq. ft.	A. Aldrin B. Chlordane C. Dieldrin D. Heptachlor	Apply dust on lawn and sprinkle with water to soak into soil. Apply spray directly onto soil at rate of 25 gal. per 1,000 sq. ft.

Pillbugs or sowbugs	These pests are not insects but often cause damage to tender plants. Light-gray to slate-colored and about ½ in. long. Roll up in shape of pill when disturbed.	A. 5% Carbaryl (Sevin) B. 5% Chlordane C. 2% Lindane	A. Carbaryl (Sevin)	Apply dust and spray directly to feeding area. Broadcast baits in early morning or late evening. Commercially prepared baits may be used.
Snails and slugs	Grayish to grayish-brown, legless, slimy, and soft-bodied slugs ½ to 4 in. long. Snails are made up of spirally coiled, conical shells about 1 inch long.	Use commercially prepared baits containing metaldehyde. A. 5% Carbaryl (Sevin)	A. Carbaryl (Sevin)	Broadcast bait in late evening or early morning.
Termites	Small trees sometimes are attacked by termites. They burrow into roots and crowns of plants. Worker termites are wingless, soft-bodied and white with dark jaws.	A. 10% Chlordane B. 2½% Dieldrin	A. Chlordane B. Dieldrin	Also, dust soil surface around plant with wettable powder. Water plant to soak insecticide into soil.
Ants	Several species may invade home lawns. Size of ants varies according to species; fire ants may be as small as 1/8 in. long; agricultural (red) ants, as large as 1/3 inch long.	A. 5% Chlordane B. 2½% Dieldrin C. 2½% Heptachlor Mirex "150" bait (for fire ants only); Mirex "450" bait (for town ant or Texas leaf cutting ant only).	A. Chlordane B. Dieldrin C. Heptachlor	These materials also are available in granular formulation. Use all formulations according to directions on manufacturer's label.
Fall armyworm, Sod webworm	Damage lawns by feeding on leaves and stems of grass. Fall armyworm has distinct, inverted white Y on front of head. Damage first appears as whitish patches in lawn where leaves have been skeletonized. The sod webworm is a dingy white larvae about 1 in. long when grown and is marked with prominent black spots. Silk-lined tunnels of earth near the soil surface are indications of the presence of this pest.	A. 5% Carbaryl (Sevin) B. 5% Chlordane C. 2½% Dieldrin D. 10% Toxaphene	A. Carbaryl (Sevin) B. Chlordane C. Dieldrin D. Toxaphene	Repeat application if new infestation develops.

Chinch bug	Primarily a pest of St. Augustine lawns in eastern half of Texas. Adult is 1/6 to 1/5 in. long with black body, reddish-yellow legs and fully developed wings. Each front wing is mostly white, but is marked with an irregular black patch at the middle of the outer margins. Newly hatched nymph is bright red and has a whitish band across the back. Adult and nymphs suck the plant juices, resulting in browned areas in the lawn. Injured areas frequently are first noted along edges of the lawn.	Granules: A. Aspon B. Carbophenothion (Trithion) C. Diazinon D. Ethion	Sprays: A. Aspon B. Carbophenothion (Trithion) C. Ethion	Granular materials are preferred for homeowner use. Cyclone-type lawn fertilizer applicators work well in applying granular insecticides. Water lawn thoroughly following granular application. Sprays are effective, but require more time and effort. Irrigate lawn thoroughly before spraying. Use 15-25 gallons of spray mixture per 1,000 sq. ft. Make applications about May 1 and repeat about July 1. Apply 0.2 lb. actual insecticide per 1,000 square feet.
Bermudagrass mites	The microscopic, eight-legged pests have caused considerable damage to Bermudagrass lawns in West and Northwest Texas. Stunted internodes are characteristic symptoms of injury. Lawn develops a generally unhealthy appearance and makes slow growth.	A. Sulfur (10 lb./ 1,000 sq. ft.)	A. Carbophenothion (Trithion) B. Diazinon C. Ethion	Two applications 10 to 14 days apart may be necessary for most effective control. Use 5 gal. of spray mixture per 1,000 sq. ft. of lawn area.

Caution: ALLOW LAWN AREA TO DRY THOROUGHLY AFTER SPRAYING BEFORE
ALLOWING CHILDREN OR PETS TO PLAY ON THE GRASS

*The preceding information was taken from Texas Agricultural Extension Publication, "Texas Guide for Controlling Insects," L-199.

4. Renovating Old Turfs

The renovating of old turfs is not as common a problem as the other problems discussed in this topic; nevertheless, it is a lawn problem that may confront the landscaper.

Before starting the renovation of an old turf, the landscaper should determine the causes of the existing condition. After the causes are determined, then a decision must be made whether to reconstruct a new turf or renovate the existing turf. A rule of thumb that may be helpful in making the decision is as follows: a new turf should be constructed when 50 percent of the grass is undesirable, or if the condition is caused by a drainage problem. If the condition is caused by low fertility, diseases, insects, soil compaction, thatch accumulation, or improper care, the lawn should be renovated.

Thatch Accumulation

A thatch accumulation is a buildup of old grass clippings and stolons. It prevents the downward movement of water in the soil and new roots from developing. Generally, the thatch can be removed by mowing the lawn as close as possible and removing the dead stems by raking the lawn. After the thatch is removed, the lawn should be fertilized and watered. Insects and diseases also should be controlled.

References:

1. "Chemical Weed Control in Lawns," Texas Agricultural Extension Publication, L-425.

2. "Control Diseases in the Home Lawn," Texas Agricultural Extension Publication, L-732.

3. "Texas Guide for Controlling Insects on Ornamental Plants," Texas Agricultural Extension Publication, L-199.

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CVAE AND VEH HORTICULTURE

Unit K: Soil and Plant Diseases, Insects, Organisms, and Weeds

Topic 1: The Safe Use of Chemicals in Controlling Diseases, Insects, Organisms, and Weeds

Note: All terms underlined are included in the "Glossary of Terms."

1. Storing Chemicals

Transparency No. 1

The storage area for chemicals should be inaccessible, an area that can be locked, and an area where the chemicals will not come in contact with human or livestock food.

The following precautions should be strictly adhered to in the storing and hauling of chemicals.

1. Store all chemicals in the original container with the lid closed tightly and the label attached. Labels on chemical containers may be protected by painting them with lacquer or by placing transparent tape over them.

2. If chemicals are loaned or sold to neighbors, they should be left in the original container. This practice provides a label. Verbal directions are easily forgotten, and unmarked containers are dangerous.

3. Large containers should be stored on the floor and in a area where there is not a possibility of their being punctured.

4. Chemicals in glass containers should be stored in a dry, cool area and away from heat.

5. Chemicals should be stored in an area that protects them from freezing.

6. Herbicides and defoliants should not be stored in the same room as pesticides and insecticides.

Volatile chemicals and their derivatives, such as 2,4D, can contaminate pesticides and insecticides.

7. Chemicals containing chlorate salts should be stored with caution. It is possible for them to explode and create a fire hazard.

8. Powdered and granular chemicals should be stored on shelves to free them of moisture and prevent them from caking.

9. Protective clothing should be worn when working in storage area.

10. Hands should be kept away from eyes and mouth.

2. Mixing Chemicals

This discussion regarding the mixing of chemicals pertains to the mixing of chemicals with water or a similar diluent. Before mixing two chemical compounds, the landscaper should determine from a compatibility chart if it is safe to mix the chemicals.

Transparency No. 2

It is important that chemicals be mixed accurately and thoroughly. The directions on the label should be followed explicitly when mixing the chemical. To do otherwise is unsafe, as well as uneconomical; and the effectiveness of the chemical may even be reduced. Also, the exposure is greatly increased when the concentration is higher than recommended.

Only the amount of chemical that can be used immediately should be mixed at one time. This prevents the necessity for a number of containers other than those intended for storing or applying the chemical.

Transparency No. 3

The above transparency contains a list of protective clothing that should be worn when mixing and handling chemicals.

When mixing chemicals, care should be taken to avoid spilling them on skin or clothing. Also, the inhalation of chemical vapor, spray mist, and dust should be avoided. One should stand with head high above the tank's fill hole while mixing chemicals. Paddles should be used to thoroughly mix chemicals.

Because chemicals may be poisonous or flammable, smoking or eating shile mixing or using chemicals is unsafe. Hands and face should be washed thoroughly with soap and water after exposure to chemicals.

The end of a water pipe or hose being used to fill a sprayer tank should be supported above the full water level of the tank to prevent back-siphoning of water and chemicals. A sprayer should never be unattended while it is being filled. Waste chemicals and rinse water should be drained into a hole covered with soil. Precautions should be taken to prevent waste water and chemicals from contaminating a source of water used by humans or animals. Some dos and don'ts when mixing chemicals are given in the transparency below.

Transparency No. 4

3. Applying Chemicals

Manufacturers of highly toxic chemicals are required to label the chemical container with a skull and crossbones, the word "Poison" in red on a contrasting background, and with a suitable antidote statement. The label also must contain precautions that should be observed when using the chemical. Other information required on the label is listed below:

(1) Specific use of the product. The manufacturer is morally obligated to give directions for the most effective use and the safe handling of the product.
(2) Label must contain adequate directions for effective use and warning against hazards of misuse.

Labels must be approved and registered with the U.S. Department of Agriculture under the provisions of the Federal Insecticide, Fungicide, and Rodenticide Act. The manufacturer is required to supply scientific research data to prove his claims and show that his directions and warnings are accurate.

Regardless of the type of chemical being applied, the landscaper should be conscious of chemical drift. Drift is the movement of the released chemical from a path of vertical descent and is caused by air movement. Drift cannot be eliminated completely when a chemical is applied by power equipment, but the quantity and extent of drift can be reduced. Drift is particularly hazardous when chemicals are applied adjacent to areas growing susceptible crops. Factors that influence drift are particle size, specific gravity, evaporation rate, height of release, horizontal air movement, vertical air movement, temperature, and humidity.

Particle size and specific gravity affect the rate of fall. Small, lightweight particles fall very slowly. For example, a 5-micron (1 micron = 0.001 inch) drop of water requires 5½ hours to fall 50 feet in still air, while a 100-micron drop under the same conditions requires only 55 seconds. Evaporation is disregarded in the example.

Dust particles are smaller than spray particles; therefore, dusts tend to drift farther than sprays. Sprays, rather than dusts, should be used when possible.

Because oil is lighter than water, oil-sprays tend to drift farther than water-sprays. However, water-base sprays have a higher rate of evaporation than oil-base sprays. The use of an anti-evaporant in water-base sprays will reduce water evaporation.

As previously stated, height of fall and horizontal and vertical air movement are factors that affect the distance a particle will drift. A 50-micron droplet of water will drift approximately 890 feet while falling 50 feet in a 3-mile per hour wind. Doubling the height or windspeed will double the distance of drift.

Sprayers can be adjusted to eliminate small particles, but the use of coarse sprays reduces the width of the swath and the number of drops per unit of area. When the average drop size is doubled, the number of drops in a gallon will be reduced to 1/8 the original number. A coarse spray may not be economical or effective in controlling some pests. A moderate coarse spray may be used for applying herbicides, since the coverage of plants with this type spray is not as critical as with some chemicals.

The best time to apply chemicals is in the early morning or late evening. The air temperature differential between the ground and 10 to 20 feet above the ground is considerably less during these periods than during the middle of the day. As the ground warms up, ground air temperature increases above that of the air at 10 to 20 feet. The warmer air rises and sets up convection and thermal air currents that lift small particles. They may be carried to some distant point before they settle out.

Calm conditions with a high inversion (ground air 2^{o} to 5^{o} cooler than air above) may cause the small spray drops or dust particles to remain suspended and undisturbed in this layer of cold air. They move out of the area before coming to rest. Applications of chemicals under these conditions should be avoided.

4. Disposing of Chemical Containers

Transparency No. 5

Certain precautions should be taken when disposing of chemical containers. The method of disposal will depend upon the type of container and facilities available. Regardless of the disposal plan one follows, the hazard of disposal can be lessened if the procedure below is followed:

1. The chemical remaining in the container should be drained into a pit dug in sandy soil.
2. The container should be rinsed several times with a diluent, and the rinse solution poured into the pit.
3. Empty containers should be kept in a secure storage area until they can be properly disposed of.

Large metal containers can be disposed of safely at local public dumps or private disposal sites. The manager of the dump should be notified as to the type of chemical the container held in order that he may take the necessary precautions. The lids and bungs should be removed, and holes should be chopped in the top, bottom, and sides of metal containers. The puncturing of the containers will usually prevent unauthorized persons from removing the containers and using them improperly. Glass containers should be broken.

Private disposal sites should be located on level ground. Water from the disposal site should not drain near a home, well, stream, crop, or livestock. The site should not be located on the watershed of a public water supply, or where livestock will have access to it.

Some containers may be decontaminated by burning. After holes have been chopped in metal containers, they may be decontaminated by heating them for at least 5 minutes at 800 to 1200° F. Herbicide containers should never be burned because the herbicide will volatilize. There is a possibility that the vapor will damage nearby plants. There is also a possibility that containers that have held herbicides and defoliants will explode when heated. This is particularly true if they contained chlorates. Herbicide and defoliant containers should be disposed of as follows:

1. Holes should be chopped in the top, bottom, and sides of containers to prevent their reuse or the collecting of water.
2. The containers should be buried to a depth of 18 inches at the disposal site.

5. Personnel and Equipment Cleanup

The operator of equipment used to apply chemicals should remove his clothing and bathe immediately after completing the application. If a meal period occurs during the application of chemicals, the operator should wash his hands and face thoroughly before eating.

In order to preserve equipment and to eliminate possible hazards, chemical equipment also should be thoroughly cleaned after use. A procedure for cleaning equipment is listed below:

1. The containers used for handling and applying chemicals should be rinsed with water and a detergent. The water and detergent should be agitated intermittently and allowed to remain in the containers for 15 minutes. The rinse water should be poured into a pit which has been dug in sandy soil. The recommended mixture of water and detergent is given below:

Container Size	Water	Detergent
5 gallons	2 quarts	2 tablespoons
30 gallons	3 gallons	½ cup
55 gallons	5 gallons	1 cup

2. The container should be rerinsed with the recommended mixture of water and detergent for another 15 minutes. This rinsing mixture is disposed of as explained above.

Cleaning the Sprayer

Sprayers should be cleaned after each use. Many chemicals are corrosive, and some are held in suspension while the sprayer is in operation. The chemical will settle out and harden if left standing for a long period of time. The sprayer tank should be flushed with water; and the nozzles, strainers, and screen should be disassembled and washed with gasoline or kerosene. All threads should be coated with cup grease or pipe compound to prevent the joints from "freezing."

A special cleaning should be given sprayers used for applying herbicides. The recommended procedure is as follows:

1. The sprayer is cleaned of the herbicide. It may be necessary to rinse the sprayer several times with water.
2. All pieces of sprayer equipment should be soaked in a 1 percent solution of household ammonia (1 gallon of ammonia to 100 gallons of water, or 2 tablespoons per quart of water).

Once the sprayer has been used to apply herbicides, it should never be used for spraying crops, ornamental plants, and shrubs. It is practically impossible to wash the herbicide from the hoses and container.

6. Residue and Tolerance

Residue is the amount of a pesticide in or on a product when it enters the marketing channel. Tolerance is the amount of a pesticide which scientists have determined may safely remain as a residue on the food crop without injury to the consumer. The tolerance is specified for the pesticide and crop and is established by government regulations.

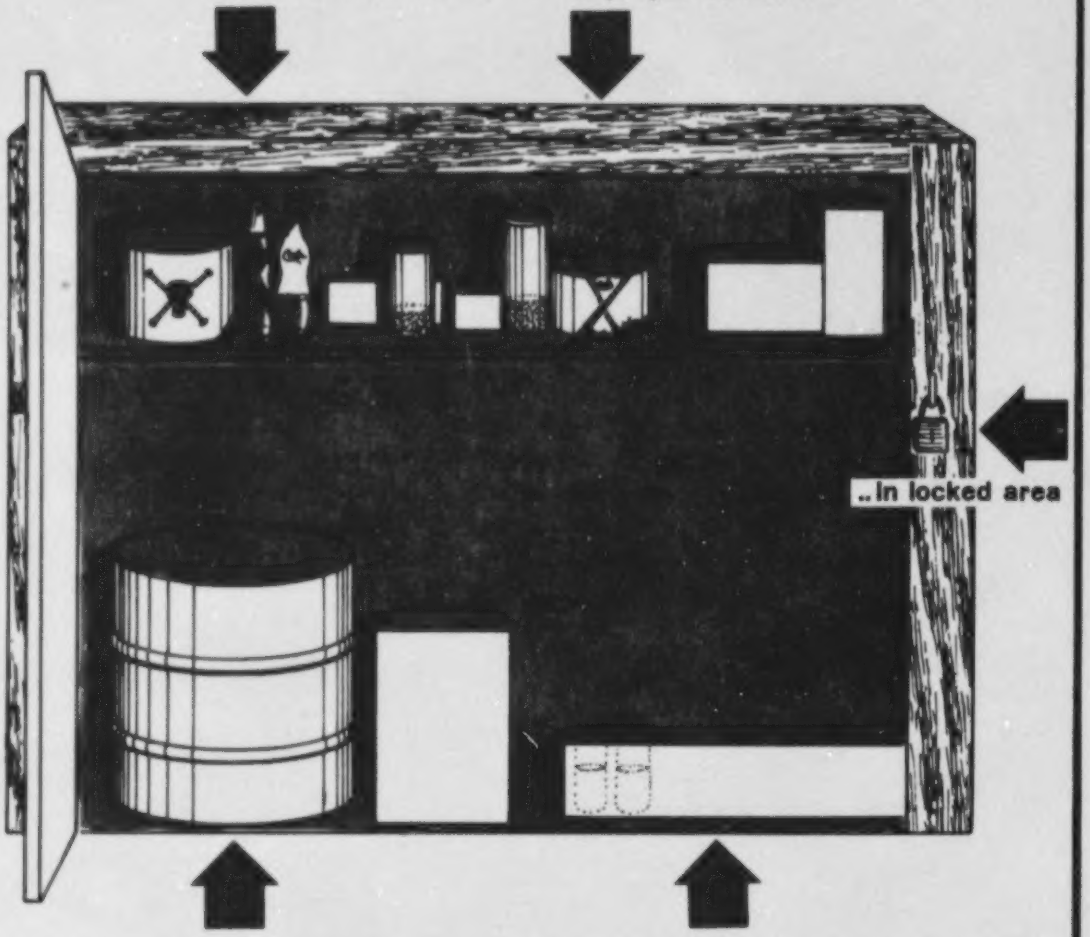
Chemical residue is measured in parts per million. The Food and Drug Administration considers the amount of residue which will remain on the crop if the chemical is used according to the directions on the label. Then the F.D.A. sets a safe tolerance which can be met if the directions for use of the chemical are followed. If it is not necessary to establish a tolerance for a chemical to protect the consumer, the F.D.A. may exempt a product from the tolerance requirements.

A limited number of pesticides have been declared safe and do not require either a tolerance or an exemption. Some chemical products have a zero tolerance, which means that there can be no residue of the chemical on the crop. The absence of a published tolerance or exemption does not necessarily imply that a pesticide may not be used. For example, some pesticides recommended for use as dormant sprays and soil treatments do not result in a residue of the pesticides at harvest. Uses of chemicals which do not leave residues do not require tolerances or exemptions and do not have to be passed upon by the Food and Drug Administration.

Many people have no conception of what constitutes one part per million residue. Some examples of one part per million are one inch in 16 miles and one minute in two years. A teaspoon of materials spread on an acre is five parts per million.

STORING CHEMICALS

STORE...



..in original container

..corrosive materials in proper containers

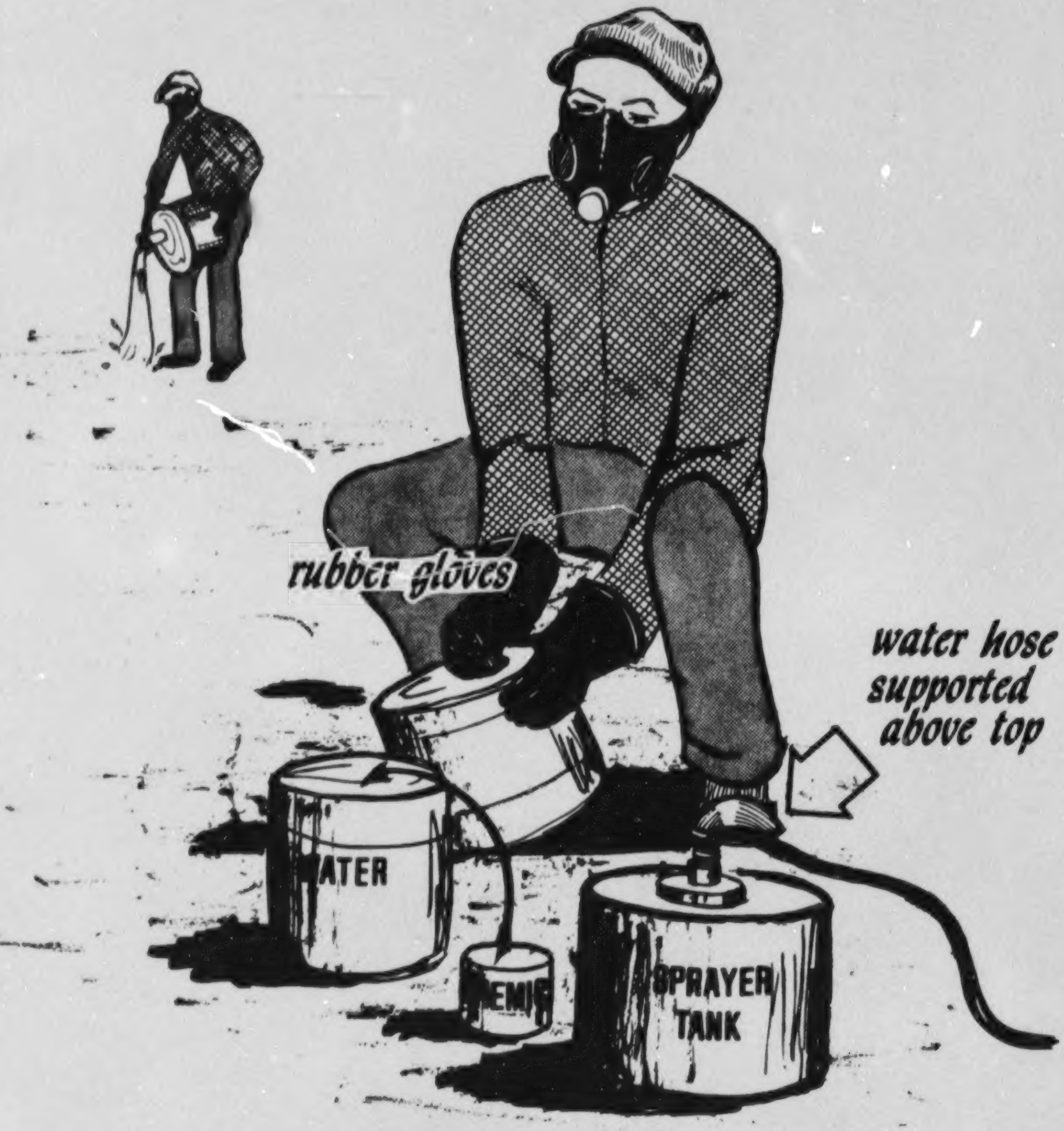
..in locked area

..large containers on floor

..glass containers in cool, dry place

..herbicides and insecticides in separate rooms

MIXING CHEMICALS


rubber gloves
water hose supported above top
ATER
EMIC
SPRAYER TANK

PROTECTIVE CLOTHING
FOR
MIXING AND HANDLING CHEMICALS

◇ LONG-SLEEVED SHIRT AND LONG PANTS
(shirt should be buttoned at neck and wrist and worn inside pants)

◇ A WIDE-BRIM HAT

◇ WATERPROOF BOOTS

◇ WATERPROOF GLOVES THAT FIT SNUGLY AROUND WRISTS

◇ SAFETY GOGGLES

◇ RUBBER OR PLASTIC APRON

◇ A RESPIRATOR WHEN MIXING AND HANDLING DUST OR WETTABLE POWDER

DO'S AND DON'TS FOR MIXING CHEMICALS

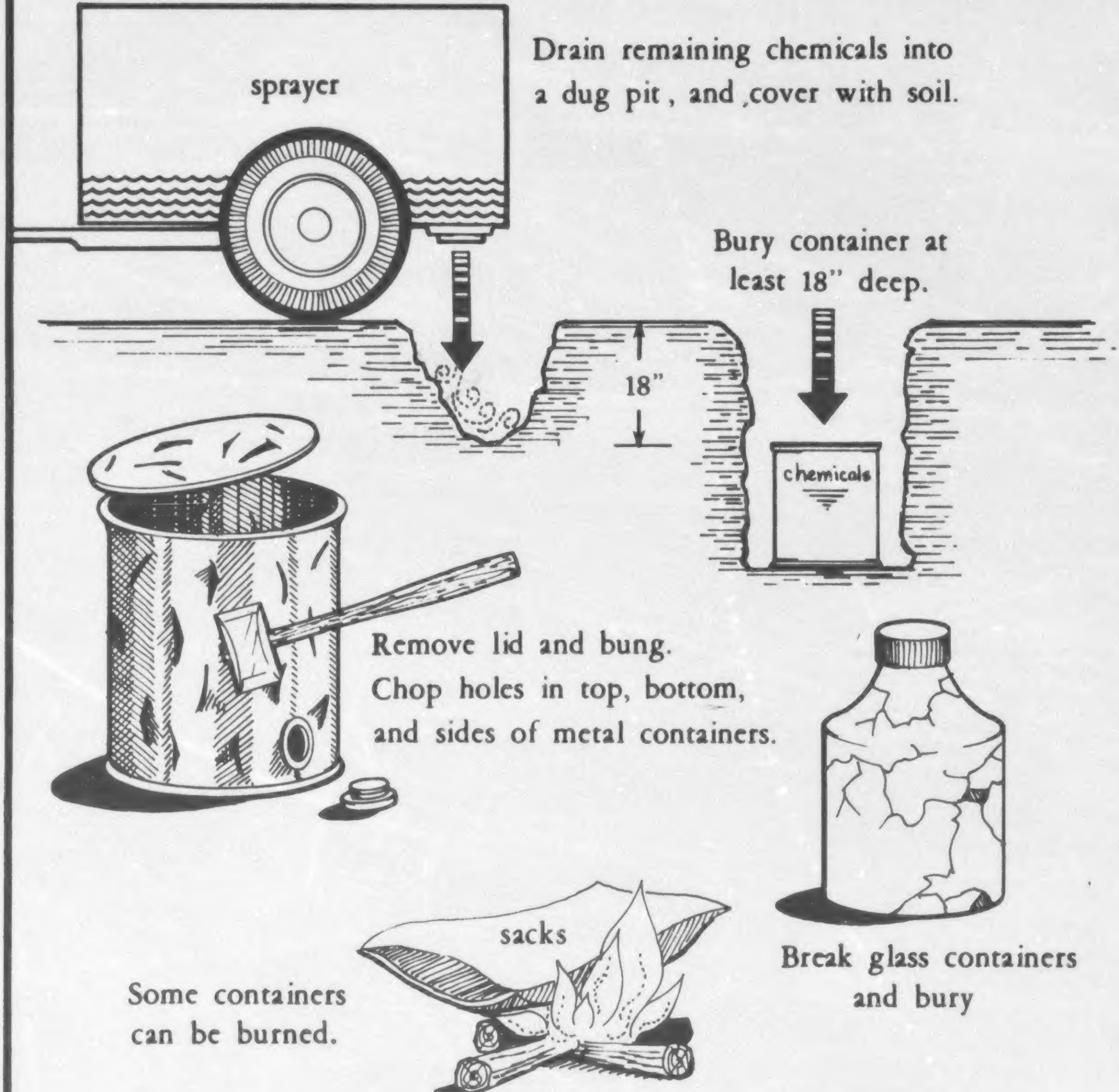
DO'S

- obtain required certification for applying
- read label at least twice everytime chemical is used
- use protective clothing
- pour dusts and powders slowly
- remove screen from fill hole of sprayer tank before putting chemicals in tank
- clean measurers and other containers after use
- dispose of empty containers properly

DON'TS

- mix chemicals that are incompatible
- mix chemicals in an enclosed room
- allow liquids to splash or spill
- think of empty containers as being harmless
- permit delivery of chemicals unless a responsible representative or employee is on hand to receive and properly store them

DISPOSING OF CHEMICAL CONTAINERS



Drain remaining chemicals into a dug pit, and cover with soil.

Bury container at least 18" deep.

Remove lid and bung. Chop holes in top, bottom, and sides of metal containers.

Break glass containers and bury

Some containers can be burned.

Vocational Instructional Services
Agricultural Education

K-2
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit K: Soil and Plant Diseases, Insects, Organisms, and Weeds

Topic 2: Identification and Control of Plant Insects

Note: All terms underlined are included in the "Glossary of Terms."

1. Introduction

There are more insects than any other animal group. It has been estimated that only a small percentage (600,000) of the insects on the earth have been identified. During the 300 million years of the existence of the earth, insects have become adapted to all types of climate and environmental conditions.

There are both beneficial and harmful insects. The latter group represents only about 1 percent of the total, but it accounts for billions of dollars of damage and losses to crops and livestock.

The body of an insect is very unusual. Its skeleton is on the outside, while the vital organs and muscles are on the inside. The hard covering on the outside of the insect's body is called exoskeleton. "Exo" means outside. Insects breathe through a number of tiny holes in the walls of their bodies, rather than lungs. Small branching tubes going to all parts of the body serve as passages for air.

Insects have unusual sense organs. Some insects have two kinds of eyes. Two or three eyes may be located on the upper part of the face, and a pair of compound eyes located on the sides of the head. A compound eye may have several thousand individual eye units. Some insects have ear drums, which may be located on various parts of the body. Other insects may not have eardrums.

The antennae perform a sensory function for some insects. The senses of touch, smell, and hearing are located in the antennae. There are a number of different types of antennae.

Insects do not have blood vessels. The fluid in their bodies corresponds to both blood and lymph and is called hemolymph. The hemolymph flows freely throughout the body cavity except while it is being moved by the dorsal vessel or heart. In some insects, the fluid is colorless, while in others, it may be yellow or green.

Insects range in size from 1/100 of an inch to 8 inches in length. Their wingspreads vary from 1/50 of an inch to 12 inches. Moths are the largest insects. Many insects can reproduce themselves in a relatively short period of time when environmental conditions are favorable.

2. Parts of an Insect

The horticulturist should be familiar with the anatomy of insects in order to understand their life cycle and to identify them.

Transparency No. 1

The body of an insect is segmented into three distinct parts: head, thorax, and abdomen. The eyes, antennae, and mouth parts are located on the head. The thorax consists of the prothorax, mesothorax, and metathorax. An insect has six legs, with each of the parts of the thorax containing one pair. The digestive and reproductive tracts are located in the abdomen. Located on the sides of the abdomen are tiny openings called spiracles. These are the external openings for the respiratory system. The insect breathes through the spiracles.

Different kinds of insects have different mouthparts. The mouthpart is an aid in identifying the insect. The more common mouthparts are chewing (caterpillars, grasshoppers, and beetles), piercing-sucking (bugs, fleas, and certain flies and bees), chewing-lapping (wasps), sponging (houseflies), siphoning (butterflies and moths), and rasping-sucking (thrips). The horticulturist, in general, will be concerned with insects that have chewing and piercing-sucking mouthparts.

Transparency No. 2

The chewing mouthparts in the transparency are those of a grasshopper. Other insects having chewing mouthparts may be modified slightly, but they will be very similar.

There are a number of mouthparts, and each part has a specific function. The labrum protects the mandible, guides the food into the mouth, and closes the opening in the mouth cavity. The mandibles are used for cutting, tearing, chewing, and grinding food. The hypopharynx (tongue) contains salivary glands which break down food. The maxillae aid in smelling, cutting, and chewing food.

The piercing-sucking mouthparts in the illustration are of a stink bug. The needle-like maxillae, together with the mandibles, form the piercing-sucking organ which enters the host plant. The mandibles, outer hair-like structures, are used for puncturing. The maxillae, inner pair, are used for taking the liquid food into the body. Each of the maxilla has two grooves on its inner surface. When the maxillae are brought together, the grooves form two canals. Saliva is pumped into the host plant through the posterior or salivary canal, and the plant sap is taken up through the anterior or food canal. The labium does not enter the host tissue when the insect is feeding.

Growth and Metamorphosis

Many insects undergo a number of changes in their forms during the period of developing from the newly hatched insect to the adult. This is called metamorphosis. Two examples of these changes in forms are the may beetle and butterflies. A grub is one form during the metamorphosis of a may beetle, and butterflies develop from caterpillars.

An understanding of the various types of metamorphosis will assist the horticulturist in identifying insects.

Types of Metamorphosis

No Metamorphosis (Ametabola)

Transparency No. 3

A silverfish is one of the insects that does not undergo a metamorphosis. The newly hatched insects of this type look the same as the adults. The only difference is that the young insects are much smaller.

Incomplete Metamorphosis (Hemimetabola)

Transparency No. 4

The chinch bug, mayflies, dragonflies, and stoneflies are a few of the insects that have incomplete metamorphosis. The stages of growth from the egg to the adult are called the nymphs. There are several growing and molting stages (shedding of skin) before the insect is fully developed into an adult.

Gradual Metamorphosis (Paurometabola)

Transparency No. 5

Grasshoppers, aphids, and squashbugs are examples of this type. The young insect resembles the adult in many respects, but they do not have wings. The nymphs undergo several feeding and molting stages before becoming adults.

Complete Metamorphosis (Holometabola)

Transparency No. 6

Most insects have a complete metamorphosis, which includes four stages of development. These are the egg, larva, pupa, and adult. The larva goes through several stages of growth and molts before it enters the pupa stage. The larvae have chewing or modified chewing mouth parts. The insect is inactive during the pupa stage but changes in appearance while it is in this stage. The insect gradually evolves into an adult.

Life Cycle of Insects

In order to control insects, their life cycle must be broken. One may begin at any point when studying the life cycle, but the adult insect is generally the best place to start.

The adult insects lay eggs in the spring, and the young insects start feeding on the vegetative parts of plants. Eventually, the young develop into adults, and the cycle is repeated. Several generations of insects can be produced if environmental conditions are favorable. The spring and summer are the active periods for insects. During the fall, the insects find protective places and spend the winter in these areas. They are inactive during these periods. Because of the wide variation of weather conditions in Texas, it is possible during some years for insects to reproduce and complete a life cycle during the winter season.

3. Insect Control

The stage in the life cycle in which the insect attacks the host plant and the overwintering stage of the life cycle are important in the control of insects. A knowledge of the feeding stage will help in identifying the insect, while a knowledge of the overwintering stage will help in determining the type of winter protection preferred by the insect. Insect numbers can be reduced by eliminating winter protection.

The methods that may be used in controlling insects are chemical, cultural, natural, and biological. A brief discussion of each is as follows:

Chemical Control

Chemicals used to control insects are called insecticides. The use of insecticides is regulated by an agency of the federal government.

Three factors are important in the control of insects. These are insect identification, selection of an insecticide, and the application of the insecticide. Since there are a number of insecticides available for controlling a particular insect, the selection of an insecticide is probably the most difficult task.

Cultural Control

The elimination of nursery debris and insect breeding areas and crop rotation are methods of cultural control.

Natural Control

Certain natural barriers, such as rivers and mountains, prevent insects from spreading from one area to another. Varmints also assist in controlling insects by eating them.

Biological Control

This method is accomplished by assisting in restoring the balance of nature. An example is the production by a horticulturist of an insect that feeds on another insect. Many segments of the agricultural industry use biological controls. The use of sterile male screw worm flies is an example.

4. Insects of Ornamental Plants

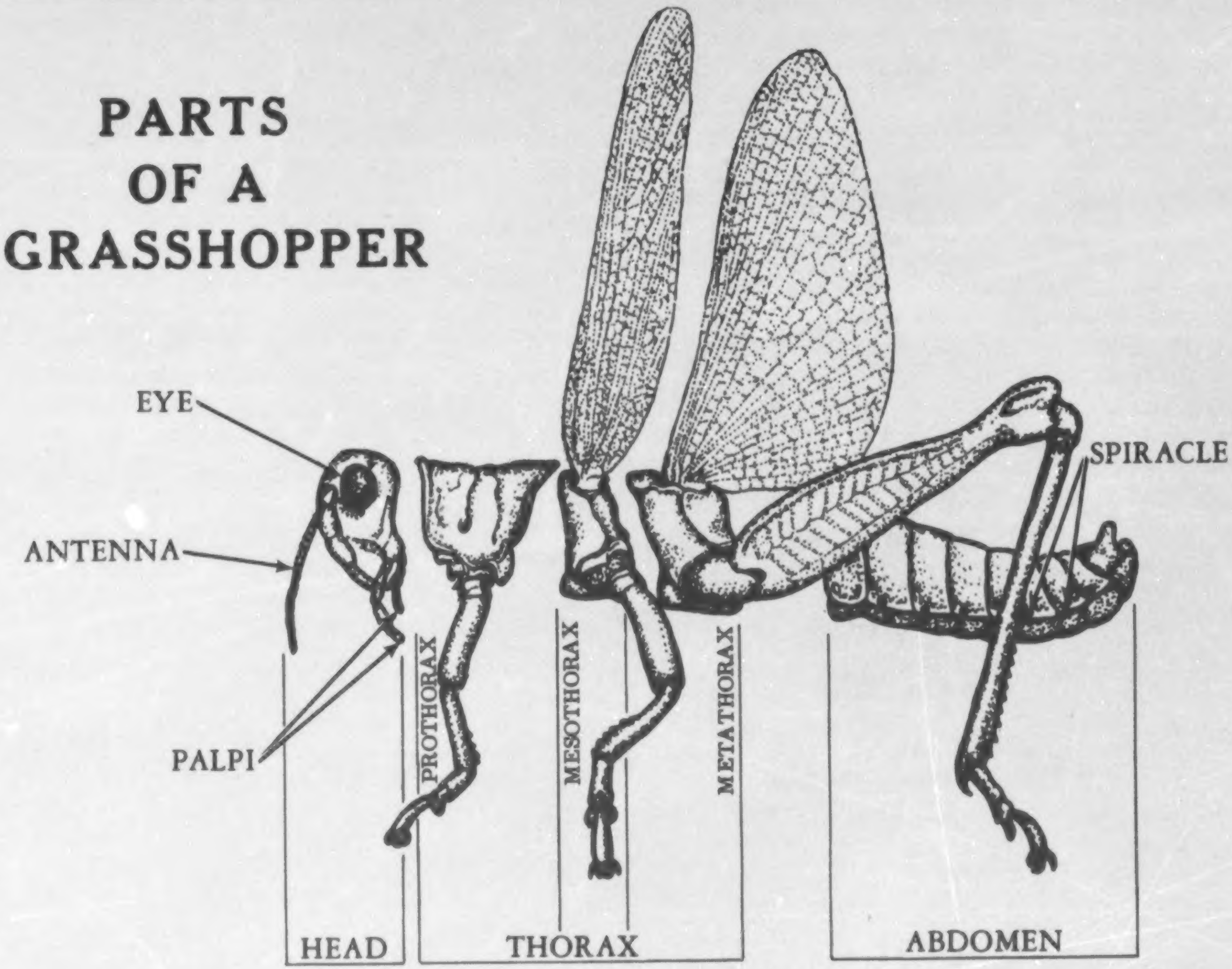
There are a large number of insects that feed upon ornamental plants. It would be impossible to list them all, but the following is a list of the more common insects.

Transparencies No. 7 and No. 8

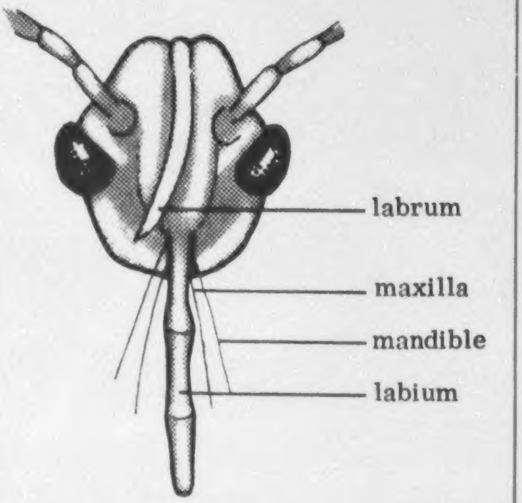
Sucking Insects
Thrip
Aphid or plant lice
Chinch bug
Lace bug
Spider mite
Mealy bug
Whitefly
San Jose scale
Oyster shell scale

Foliage - Eating Insects
Bagworm
Webworm
Tent caterpillar
Grasshopper
May beetle
Climbing cutworm
Army worm

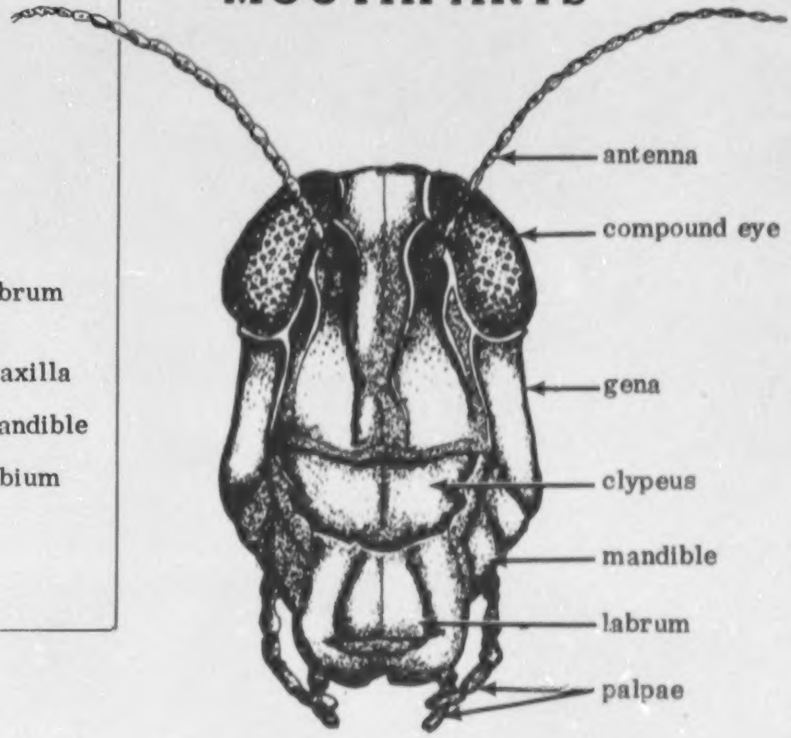
PARTS OF A GRASSHOPPER

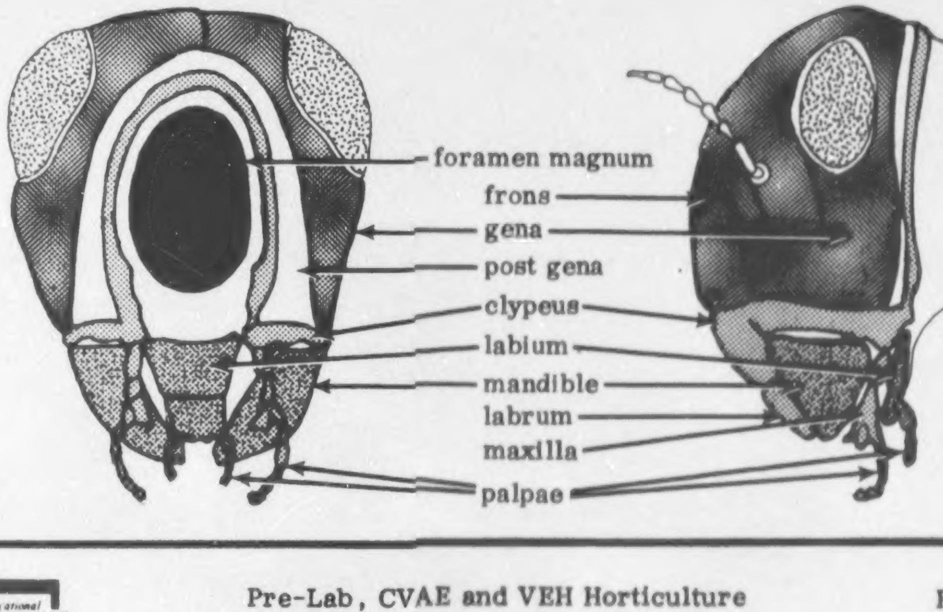

EYE
ANTENNA
PALPI
SPIRACLE
PROTHORAX
MESOTHORAX
METATHORAX
HEAD
THORAX
ABDOMEN

PIERCING-SUCKING MOUTHPARTS

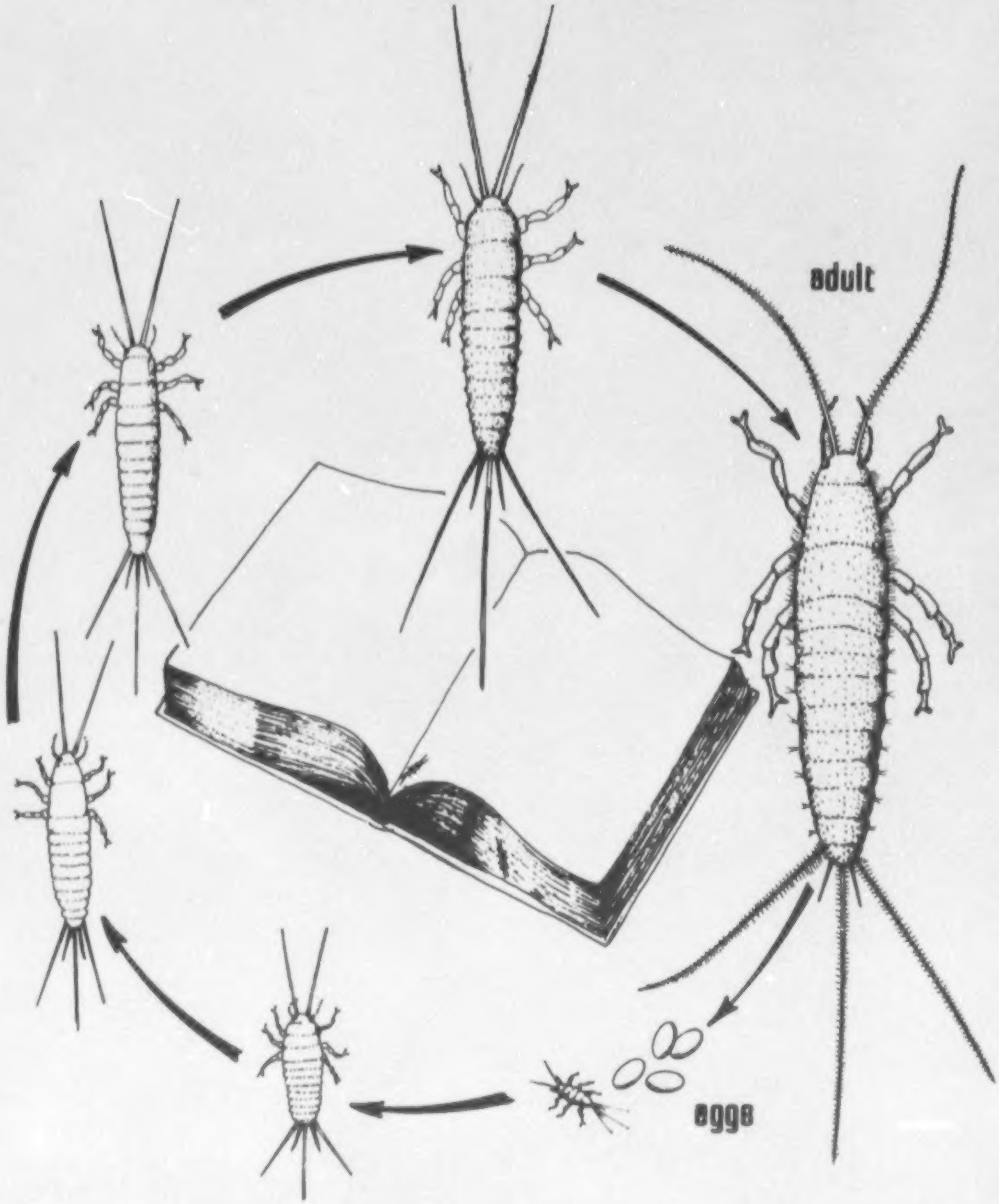

labrum
maxilla
mandible
labium

HEAD AND CHEWING MOUTHPARTS

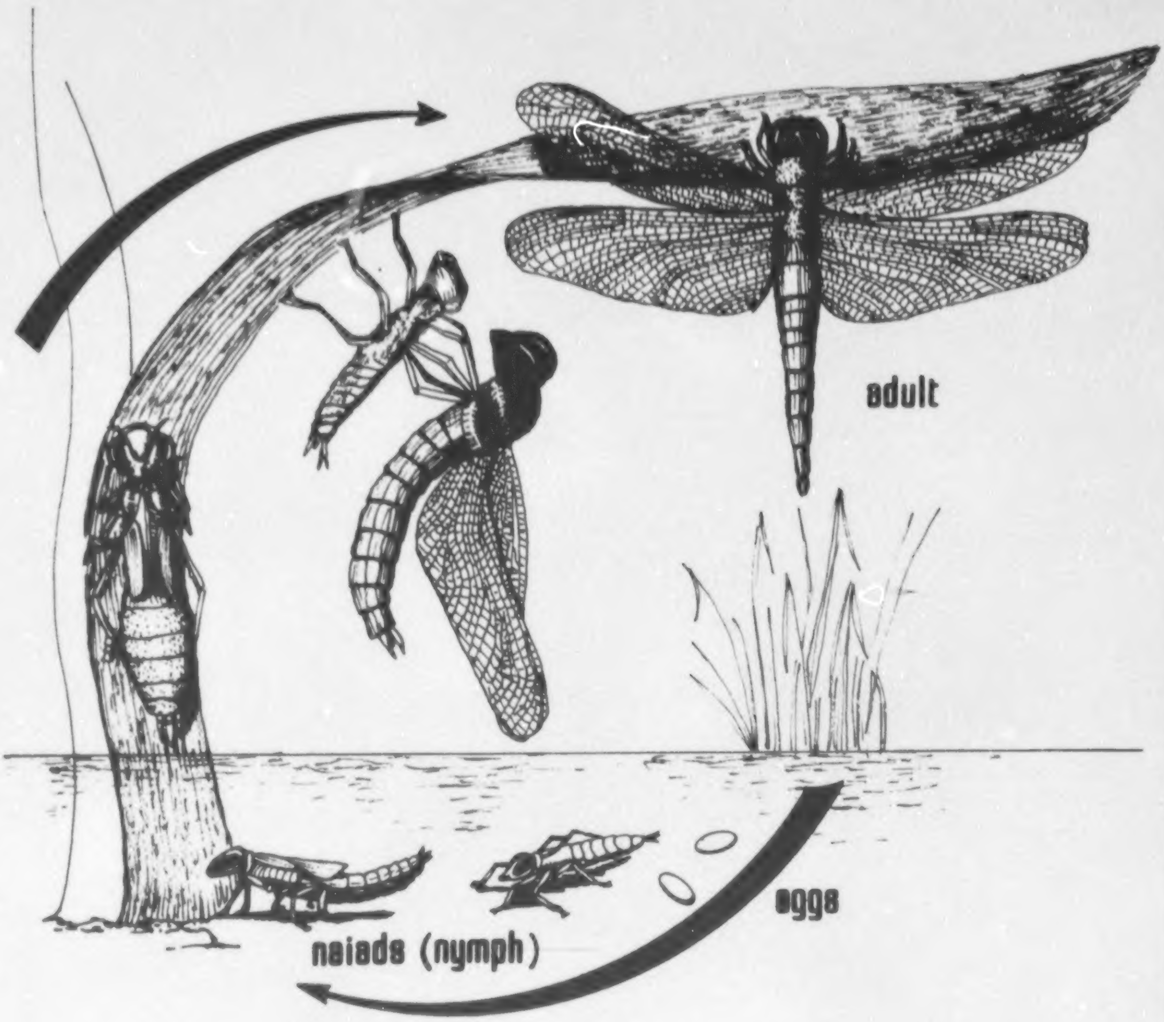

antenna
compound eye
gena
clypeus
mandible
labrum
palpae


foramen magnum
frons
gena
post gena
clypeus
labium
mandible
labrum
maxilla
palpae

NO METAMORPHOSIS



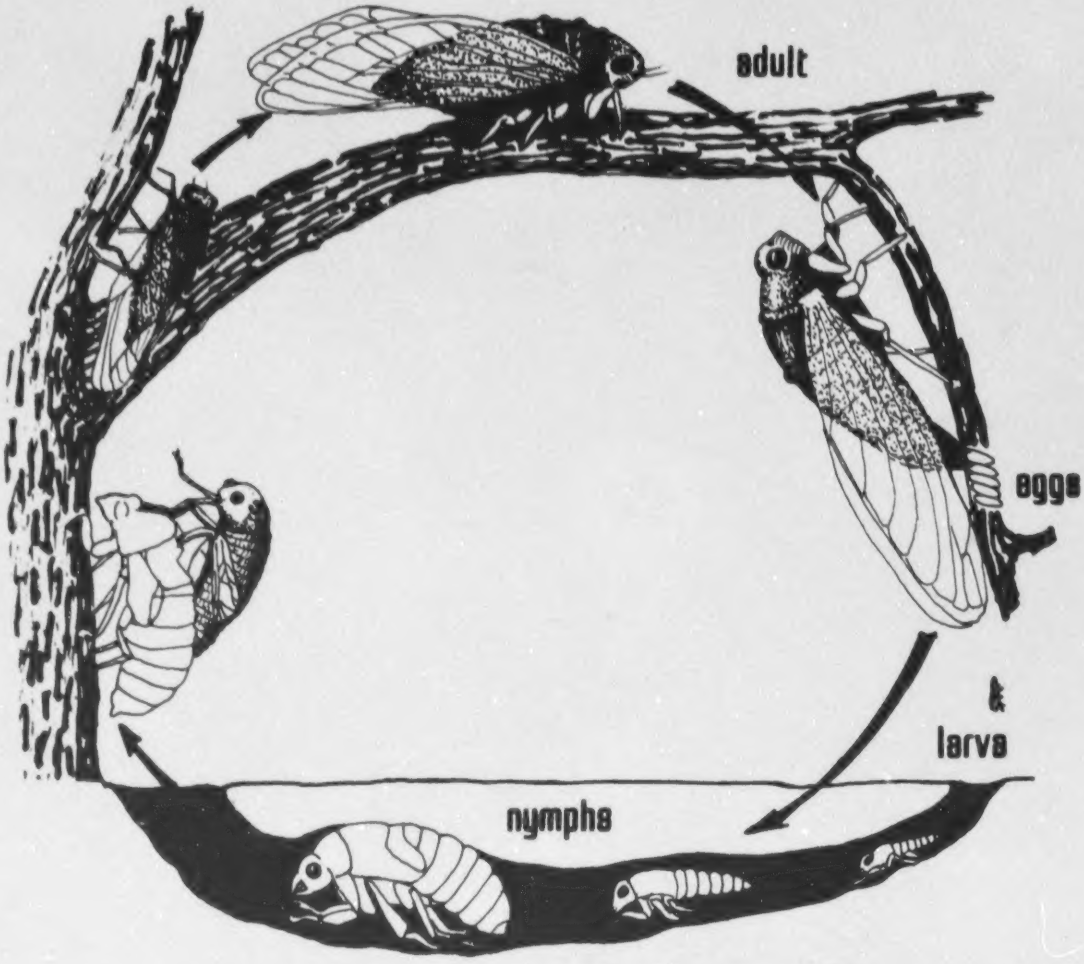
INCOMPLETE METAMORPHOSIS


adult
eggs
naiads (nymph)

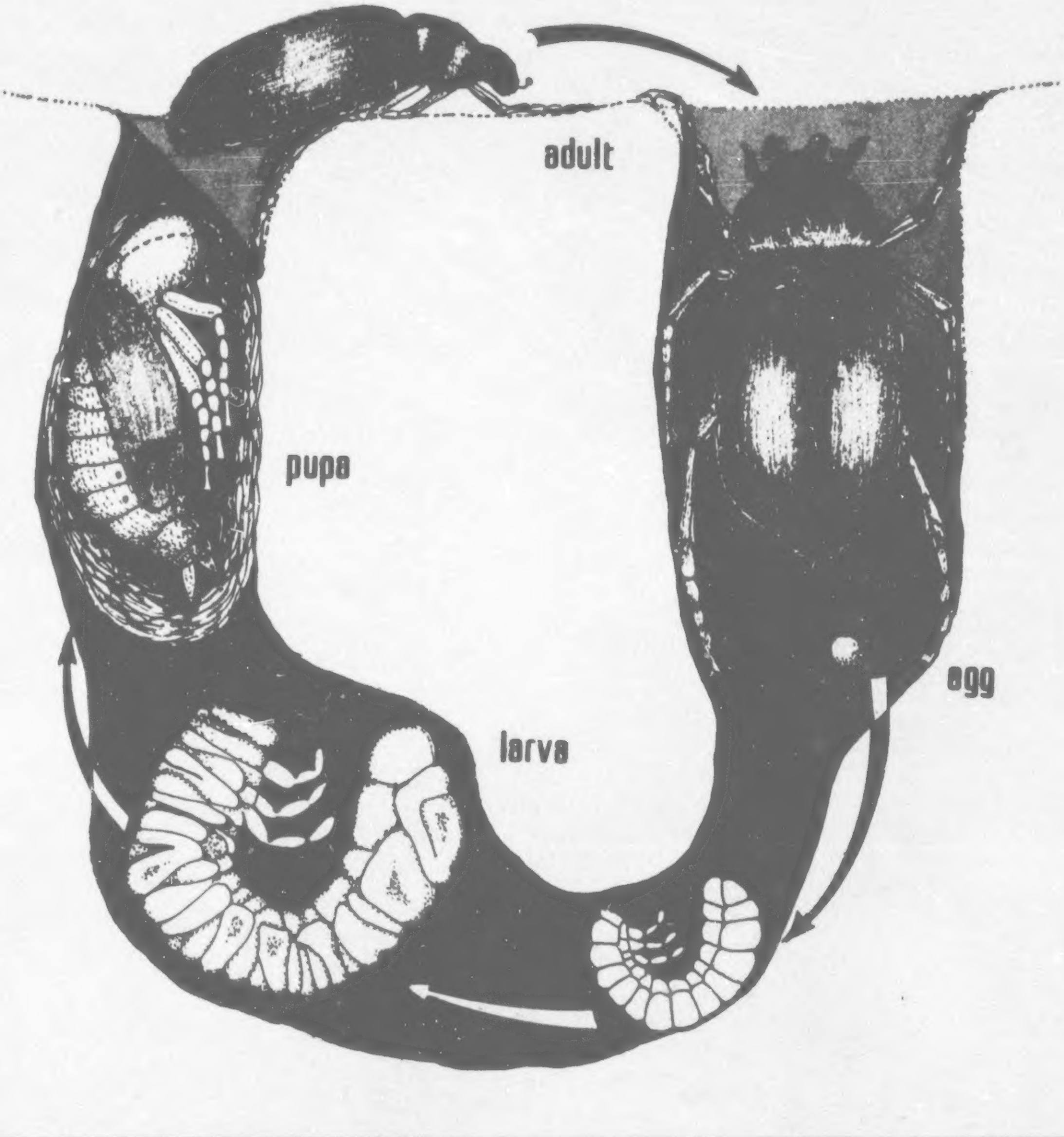
Pre-Lab, CVAE and VEH Horticulture

K-2
No. 4

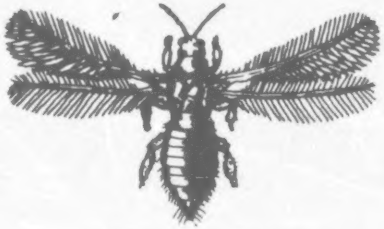
GRADUAL METAMORPHOSIS

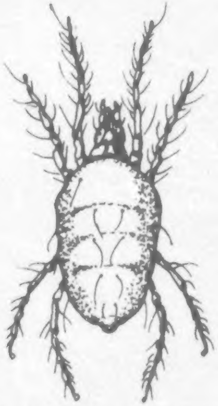

adult
eggs
&
larva
nymphs

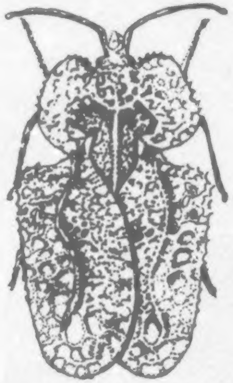
COMPLETE METAMORPHOSIS

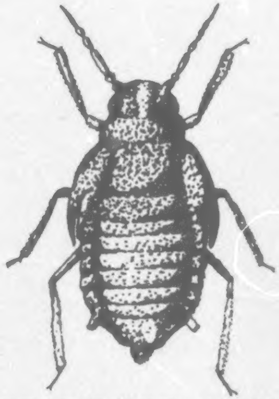

adult
pupa
egg
larva

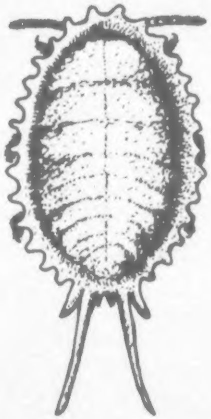
COMMON FOLIAGE SUCKING INSECTS

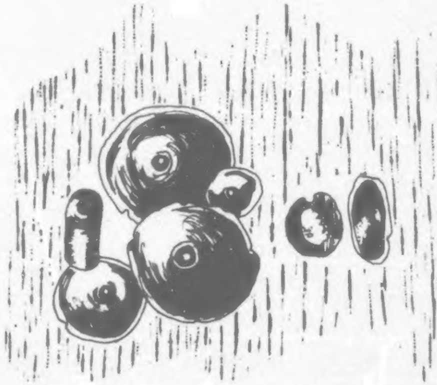

PEAR THRIP

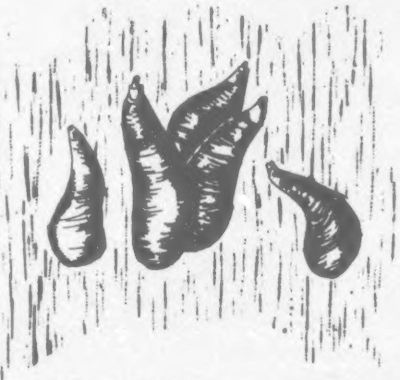

FOUR-SPOTTED
SPIDER MITE

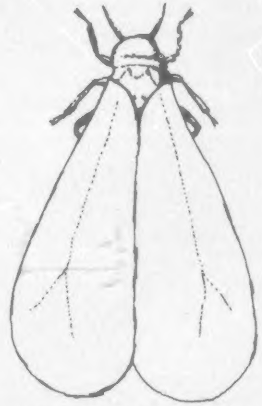

SYCAMORE
LACE BUG


CORN ROOT APHID


GRAPE
MEALY BUG


SAN JOSE SCALE


OYSTER-SHELL SCALE


GREENHOUSE
WHITEFLY

Pre-Lab, CVAE and VEH Horticulture

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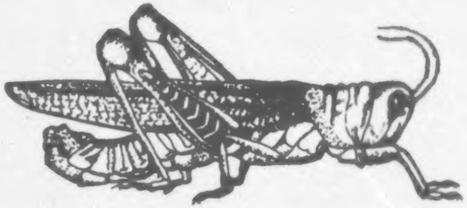
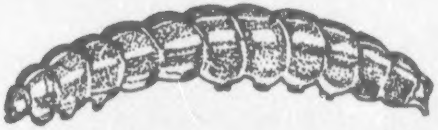
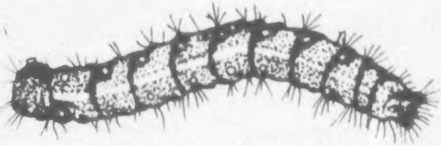
No. 7

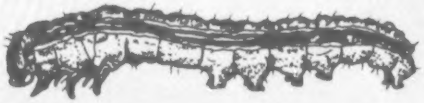
COMMON FOLIAGE - EATING INSECTS

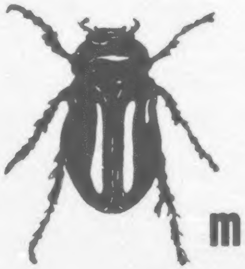

spur-throated grasshopper

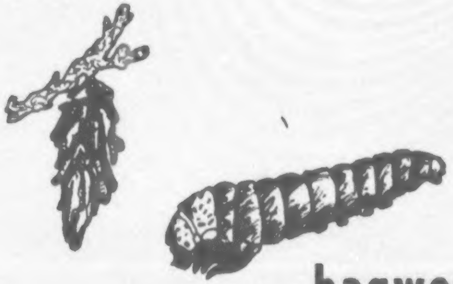

climbing cutworm

webworm


tent caterpillar


army worm


may beetle


bagworm

CVAE AND VEH HORTICULTURE

Unit K: Soil and Plant Diseases, Insects, Organisms, and Weeds

Topic 3: Identification and Control of Plant Diseases

Note: All terms underlined are included in the "Glossary of Terms".

Suggested Procedures and Activities:

"Diseases of Ornamental Plants", MP-574, Texas Agricultural Extension Service, contains information on specific ornamental diseases and their control.

1. Plant Diseases

A disease is an abnormal physiological process which affects plants in one of three different ways: (1) a breakdown of cells, (2) a stop in growth, and/or (3) abnormal growth or development. A disease is a living process, even though dead plants may harbor it.

For a plant disease to develop, a susceptible plant must be growing in an environment favorable to the disease. A knowledge of environmental conditions in which diseases develop is helpful in identifying them. A knowledge of age and stage of plant growth when a disease is most likely to attack plants is also helpful in identifying diseases.

2. Identifying Plant Diseases

There are numerous plant diseases which affect from one to several kinds of crops. The first step in identifying a disease is to determine its cause. The causes of plant diseases may be placed in two classifications: (1) noninfectious (physiological disorders), and (2) infectious.

Transparency No. 1

Noninfectious disorders are caused by something other than a living, disease - causing organism. These causes are as follows:

1. Nutritional deficiencies
2. Mineral toxicants
3. Lack of or excess of soil moisture
4. Too low or too high temperature
5. Lack of or excess of light
6. Lack of oxygen
7. Air pollution
8. Soil acidity or alkalinity (pH)

Infectious plant diseases are caused by (1) fungi, (2) bacteria, (3) viruses, (4) nematodes, or (5) parasitic plants. An infectious disease normally produces characteristic symptoms on a part of the plant. Infectious diseases and their symptoms are given below.

Transparency No. 2

Fungi

Fungi are tiny thread-like microscopic plants which are often referred to as mold. The mold produced by fungi may be white, black, gray, or brown. A single plant is called a fungus. A fungus has filaments (strings) which are called hyphae. Fungi must acquire food from an external source such as other living plants. They reproduce from spores produced on the tips of the filaments. Spores are produced in very large numbers and attach themselves to foliage, fruit, roots, and stems.

Symptoms of fungi are (1) death of a part of the plant, (2) stunting a part or all of the plant.

Fungus diseases that kill a part or all of a plant or stunt the growth of plants are root rot, damping-off, canker, leaf spot, scab, blight, soft rot, and dry rot.

Clubroot, galls, warts, witches'-brooms, leaf curl, wilt, rust, and mildew are fungus diseases which cause excessive growth of a plant or plant parts.

Bacteria

Bacteria are single-celled plants which increase by division. A cell divides and produces two cells. Cell division continues as long as conditions are favorable.

The symptoms of bacterial diseases are the same as those of fungus diseases. Bacteria are spread by wind, water, or contact.

Viruses

Viruses are rod-shaped and are so small that they can be seen only by using an electronic microscope.

Virus symptoms are a mosaic or mottling pattern, ringspots, streaks, or yellowing of the leaves and stunting and malformation of the plant. Viruses may be carried by seed, tubers, and bulbs; or they may enter a plant through vegetative propagation, insect feeding, or mechanical inoculation.

Nematodes

Nematodes are round, slender, thread-like worms about 1/70 of an inch long.

They inject a tiny spear-like mechanism into the plant and withdraw plant juices. There are several different types of nematodes, and they may feed on buds, roots, and stems of plants.

Symptoms of nematodes are root knots (galls), root lesions, excessive root branching, root rots, and injured root tips.

Parasitic Plants

Parasitic plants acquire their food from host plants. If allowed to continue to grow, they will weaken or kill the host plant. Since parasitic plants grow on other plants, they are easy to identify. Mistletoe, lichens, moss, and dodder are examples of parasitic plants.

3. Effects of Diseases on Plants

Diseases affect photosynthesis, respiration, and translocation of water and nutrients in plants. Diseases which destroy leaf tissue interfere with the photosynthesis process. To offset a decrease in the energy furnished by diseased leaves, the healthy leaves must provide more energy to the plant.

A pathogenic infection in plants causes an increase in the rate of respiration. An increase in respiration interferes with the process of oxidation and decreases its efficiency.

Plants transport water and nutrients from the roots to the rest of the plant, the translocation process. Food is manufactured in the leaves and is transported to all parts of the plant. Diseases affect the translocation process by preventing or impairing the movement of water, nutrients, and food.

4. Controlling Plant Diseases

The methods used to control disease are (1) regulatory, (2) cultural, (3) biological, (4) physiological, and (5) chemical.

Regulatory control refers to federal and state laws which regulate the conditions under which plants may be grown and marketed.

Cultural control of diseases is accomplished by applying cultural practices such as crop rotation, eradication of hosts, and improving soil condition.

Biological control is the selecting and breeding of plants for their resistance to disease and the use of trap crops.

Physiological control is accomplished by applying heat and radiation to kill disease organisms.

Chemicals are the most often used means of controlling diseases. Depending upon the type of pathogen to be controlled, chemicals are referred to as pesticides, fungicides, bactericides, nematodicides, viricides, or herbicides. The application of chemicals affects the pathogen in one or more ways. They may inhibit germination, growth, and multiplication or kill the pathogen.

Types of Chemical Application

Transparency No. 3

Several types of chemicals and several methods of applying chemicals are available to the horticulturist. A discussion of several chemicals and their application is as follows:

1. Foliage sprays and dusts - These are generally applied to control the disease rather than to kill the pathogen; however, chemicals are available in these forms that will kill pathogens. The protective type of pesticide (type used to control diseases) must be present on the surface of the plant when the pathogen arrives.

   The spray or dust must completely cover the foliage to provide the proper protection. Materials, a spreading agent, can be added to sprays to make them spread and stick to foliage. Some materials used as spreading agents do not make the spray stick to the plant, so it may be necessary to add a material to make the spray stick. Sprays are usually more effective than dusts.

2. Seed treatment - To prevent disease damage from pathogens after planting, the worker should treat seeds, tubers, bulbs, and roots before they are planted. Seed treatment not only controls disease pathogens but improves the stand, yields, and quality of the crop.

   Methods used for treating seeds are (1) liquid, (2) dust, and (3) slurry. The horticulturist using the liquid method allows the seeds to soak in the liquid and then dries them before planting. The seeds are covered by dust when the dust method of treating seeds is used. When a slurry is used, the seeds are dipped in the slurry, removed, and allowed to dry before planting.

3. Soil treatment - Fumigants are used to treat soils. Generally gaseous fumigants such as methyl bromide are used.

4. Surface applications - The disease is controlled by applying the chemical to the soil. The chemical may be left on the soil surface, worked into the soil, or applied in rows.

5. Soil drench application - This method is used to control seedling or cutting diseases. The chemical is diluted in water and may be applied by several different means.

6. Systemic application - The chemical is applied to the soil and is absorbed by the plant and transported to all parts of the plant through the vascular system.

7. Postharvest disease control - This is the method used to control diseases of fruits and vegetables while they are in storage. Several different control measures are used. The fruit or vegetables may be dipped in a diluted solution of chemicals, or the chemicals may be applied in vapor form. Some chemicals are impregnated in the containers and wrappers used to market the products.

CAUSES OF NONINFECTIOUS DISEASES

- NUTRIENT DEFICIENCIES
- MINERAL TOXICANTS
- LACK OR EXCESS OF SOIL MOISTURE
- TOO LOW OR TOO HIGH TEMPERATURE
- LACK OR EXCESS OF LIGHT
- LACK OF OXYGEN
- AIR POLLUTION
- SOIL ACIDITY OR ALKALINITY (pH)

INFECTIOUS DISEASES & THEIR SYMPTOMS

FUNGI

KILL PARTS OF PLANT
STUNT PLANT
CAUSE EXCESSIVE GROWTH

BACTERIA

PRODUCE THE SAME SYMPTOMS AS FUNGI

VIRUSES

PRODUCE VEINCLEARING
- mosaic or mottling pattern
- ringspot
- streak
- yellowing
- stunting
- malformation

NEMATODES

PRODUCE ROOTKNOT OR GALLS
- root lesions
- excessive root branching
- root rot
- injure root tips

PARASITIC PLANTS

PLANTS GROWING ON HOST PLANT

TYPES OF CHEMICAL APPLICATIONS

FOLIAGE SPRAYS AND DUSTS

SEED TREATMENT

SOIL TREATMENT

SURFACE APPLICATION

SOIL DRENCH APPLICATION

SYSTEMIC APPLICATION

POSTHARVEST DISEASE CONTROL

Vocational Instructional Services
Agricultural Education

L-1
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit L: Floral Arrangements

Topic 1: Floral Design Accessories

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

The students should be given the opportunity to use the floral materials mentioned in the topic in the designing of flower arrangements.

1. Introduction

Arranging flowers and other floral materials into an arrangement is called floral design. The design should be attractive and pleasing. Floral design has several categories. The three most common categories are: (1) artistic design (used for many different occasions), (2) wedding design, and (3) funeral arrangements. Some retail florists specialize in one or more of the categories. Imagination, originality, and a knowledge of flowers and floral materials are the principal requirements for becoming a floral designer.

The history of floral design can be traced to Europe and the Orient. Originally European designers used mass and color in their arrangements, while the Chinese and Japanese used a line design composed of only a few flowers and many twigs and branches.

2. Flowers, Plants, and Decorative Materials

As previously stated, a successful floral designer must have product knowledge. This includes the names of (1) cut flowers, (2) foliage and flowering pot plants, and (3) green materials used in design work. The designer must also be familiar with decorative materials such as (1) containers, (2) ribbon, (3) netting, and (4) holding devices.

Some of the most popular cut flowers, flowering pot plants, and foliage plants are listed as follows:

Cut Flowers

Flower	Uses	Colors	Keeping Quality	Season	Priced
Hybrid Tea Roses (The most popular rose because of larger flowers and longer stems)	Hospital arrangements, Corsages, boutonnieres, centerpieces, funeral design	Red, yellow, pink, white, and orange red	Three to five days	Year-around; special markets at Christmas, Easter, Valentine's Day, Mother's Day	According to stem length; bunches of 25 wholesale; 12 retail
Floribunda (Sweetheart) Roses	Hospital arrangements, corsages, centerpieces	Red, light pink, yellow, and white	Better than hybrid tea roses	Year-around	According to stem length; bunches of 25 wholesale; 12 retail
Standard Chrysanthemum	Corsages, home arrangements, funeral designs	Yellow, white, bronze	Excellent	Year-around	According to flower size; by the dozen retail
Pompon Chrysanthemum	Funeral baskets and vases, hospital arrangements, and centerpieces	Yellow, white, bronze, lavender	Excellent	Year-around	By 9-12 ounce bunches
Fujii Chrysanthemum	Funeral sprays and baskets, centerpieces, hospital arrangements	Same as above	Excellent	Year-around	By dozen according to stem length and flower size
Disbud Chrysanthemum	Centerpieces, hospital arrangements, funeral designs	White, yellow, bronze	Excellent	Year-around	By the dozen
Regular Carnation	Boutonnieres, centerpieces, funeral designs, corsages, vase, arrangements	Red, white, yellow, pink	Excellent	Year-around	By stem length, flower size, and in bunches of 25 stems wholesale; 12 retail

Miniature Carnation	Corsages and centerpieces	Variegated, light pink, white, red	Excellent	Year-around	By bunches of 25 to 30 open blooms (wholesale and retail)
Gladiolus	Funeral vases or baskets, vase arrangements for home and hospital	All colors	Good	Year-around	By dozen according to size of flower spike (wholesale and retail)
Snapdragon	Hospital and home arrangements, centerpieces, funeral designs	All colors	Good	Year-around	By dozen according to spike size (wholesale and retail)
Aster	Home and hospital arrangements, funeral baskets, and sprays	Full range	Good	Year-around	By the dozen
Orchid	Corsages, wedding, bouquets, funeral sprays, arrangements	Cattleyas: white and lavender; Cymbidium: yellow, brown, green, and lavender	Excellent	Cattleyas-year-around; Cymbidiums-spring	Individually by size of flower
Gardenia	Corsages, wedding bouquets, and small vase arrangements	White	Fair	Year-around	By size of flower in boxes of 8, 10, or 12 flowers wholesale; Individually retail
Iris	Home and hospital arrangements, and corsages	Blue, yellow, and white	Fair	Winter and Spring	By the dozen

Easter Lily	Funeral design and vase arrangements	Mainly white	Fair	Mostly spring	By the stem or individual flower

Flowering Pot Plants

Plant	Priced	Colors	Season
Poinsettia	According to number of flowers and pot size	Red, white, and pink	Christmas
Azalea	According to pot size (6-12 inch range)	Red, pink, white, and variegated	Winter through spring; especially Christmas, St. Valentine's Day, and Easter
Easter Lily	According to the number of flowers and buds	White	Easter
Chrysanthemum	According to pot size and height (range 12-18 inches)	White, yellow, bronze, red, pink, and lavender	Year - around
Geranium	By size of pot (usually 4 inch pot)	Red, light pink, salmon, brick red, and white	Spring and early summer
Hydrangea	By number flowers per pot	Blue, pink, and white	Easter, Mother's Day and Memorial Day
African Violet	By pot size and variety (usually in 2 1/2", 3", or 4 inch pots)	Purple, blue, pink, rose, white, and variegated	Year - around
Wax Begonia	By size of pot (usually 4 inch or 6 inch pots	Pink, red, and white	Spring and summer

Gloxinia	By size of pot (usually 6 inch pots)	Red, white, and pink	Christmas; a few for Mother's Day

Foliage Plants

Plants	Color	Growth	Leaves
Philodendron oxycardium	Dark green	Climbing or trailing	Heart-shaped 3 to 5 inches in length, 1 to 3 inches wide
Philodendron panduriforme	Dark green	Climbing	Upper leaves are fiddle-shaped; lower leaves may be oblong
Split - Leaf Philodendron	Dark green	Vine - like	Large, heart-shaped leaves with long cuts, indentations, and small holes
Variegated Peperomia	Green and white variegated	Erect but compact	Thick, waxy, heart-shaped
Watermelon Begonia	Light and dark green striped	Erect and compact (4-6 inches in height)	Medium size, heart-shaped, striped leaves
Dracaena godseffiana	Green splotched with white	Tree - like	Long and narrow leaves (6-10 inches long, 2 1/2 inches wide)
Dumbcane	Green with light green blotches	Erect (usually 2 to 4 ft. high)	Oblong (3 times as long as broad)
Roeh's Dieffenbachia	Green with pale green areas and white blotches	Erect (usually 2 to 4 ft. high)	Oblong (3 times as long as broad)
Devil's Ivy	Variegated green and yellow	Climbing or trailing	Oval, variegated (1 to 2 inches wide and 2 to 3 inches long)

Chinese Evergreen	Green	Erect or moderately spreading; may be grown with stem in only water	Oblong leaves
Rubber Plant	Dark green	Tree - like	Thick, oblong (8-12 inches long, 3-4 inches wide)
Parlor Palm	Green	Reed - like stems growing 1 to 4 ft. tall; tolerant of low light intensity	Made up of several narrow leaflets in palm fronds
Schefflera	Green	Tree - like	Made up of 5-9 leaflets in palmate shape at the end of long pedicels
Sansevieria (There are several other varieties)	Pale green bands	No stems; thick, erect leaves; tolerant of low light intensity	Long, narrow, green leaves (up to 2 1/2 ft. long and 1 inch wide)
Boston Fern	Green	Erect and compact	Feather - like, compound leaves (1-2 ft. in length and 1-4 inches wide)

Green foliage used for flower arrangements is often produced locally. However, it may also be purchased from several sources. A list of the most commonly used green foliage plants appears below:

1. Arborvital
2. English ivy
3. Privet
4. Boxwood
5. Asparagus fern
6. Magnolia
7. Rhododendron
8. Laurel
9. Galax
10. Emerald palm
11. Eucalyptus
12. Hemlock

3. Holding Devices, Containers, and Supplies

Transparency No. 1

Holding devices are used to hold flowers, foliage, and other decorative materials upright in containers. Florist clay is used to anchor some of the holding devices to the bottom of containers.

Transparency No. 2

Containers are used to hold flowers, foliage, and other decorative materials used in arrangements. They are made of pottery, plastic, wood, metal, paper mache', or glass. Containers are available in many shapes, sizes, and colors.

The color of the container should complement the color of the flowers in the arrangement, as the flowers are the most important part of the arrangement. If necessary, the color of the container can be changed by spray painting it.

Texture of container and flowers should be similar. For example, when fine textured flowers such as orchids are used, the container should be made of silver or chrome, fine china, or fine glass. When coarse textured flowers such as zinnias are displayed, rough wood or basket containers are used.

Bases or stands are used to add height and balance to an arrangement and are considered a part of the container. They should harmonize with the scale of the arrangement.

Transparency No. 3A and 3B

Numerous florist supplies are available. In fact, they are too numerous to list all of them. Frequently used supplies are shown in the above transparency.

Wire supports are used in many arrangements and are also used in constructing corsages. Wire sizes vary from 18 to 36 gauge. Eighteen gauge has the thickest diameter. Wire normally is available in 12 - to 18 - inch lengths and may be enameled or plain.

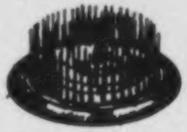
Floratape is another item used by florists. It will stretch and is available in green, light green, white, orchid, and brown colors and in 1/2 - and 1 - inch widths. It is used to cover wire and stems of corsages.

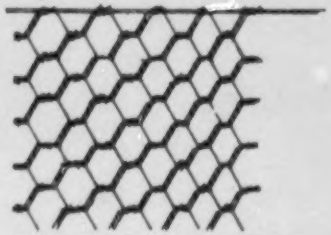
Ribbon is used in the designing of corsages, wedding designs, and certain funeral pieces. It is available in many colors, designs, and widths. Materials used in making ribbon are acetate, tinsel, rayon, and satin.

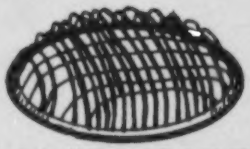
Other items frequently used by designers are water picks, frames, thread, chenille stems, spray paint, corsage pins, styrofoam novelties, wax rolls, string, and foil.

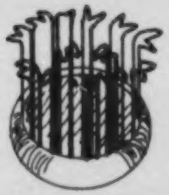
Much of the information in this topic was taken from "Retail Flower Shop Operation and Management", a student handbook, The Pennsylvania State University, University Park, Pennsylvania.

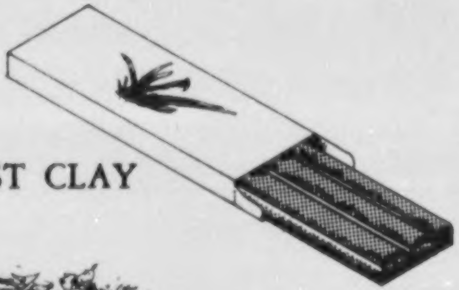
HOLDING DEVICES

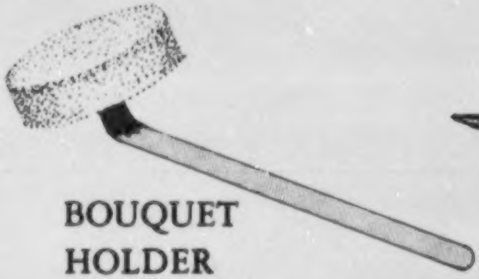

PIN HOLDER

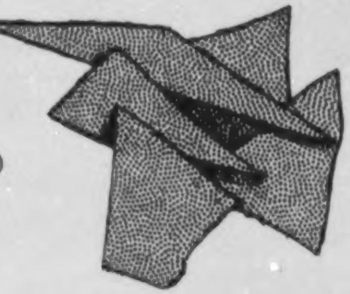

CHICKEN WIRE

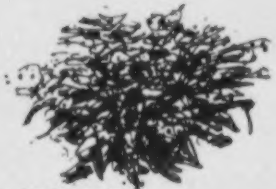

CAGE HOLDER

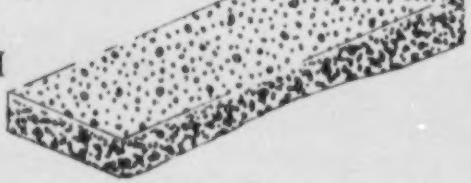

HAIR PIN HOLDER

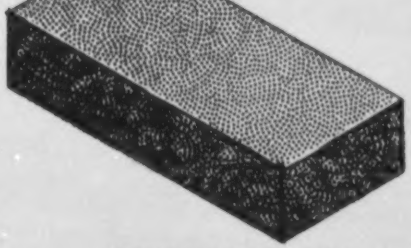

FLORIST CLAY


BOUQUET HOLDER


CHIPPED HYDROFOAM

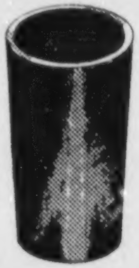

SHREDDED STYROFOAM


STYROFOAM BAR


HYDROFOAM

CONTAINERS

POTTERY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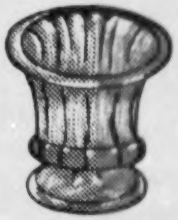
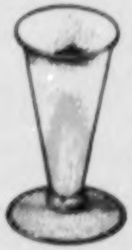
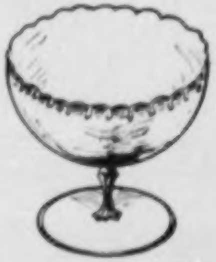

PEDESTAL


FLARE VASE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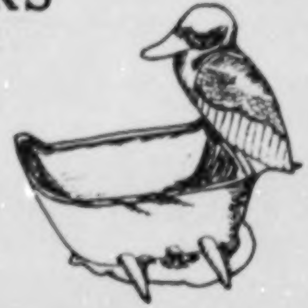
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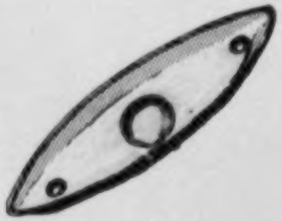

CANDLESTICK TRAY

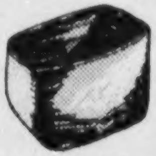
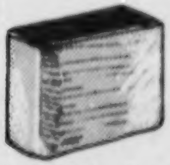
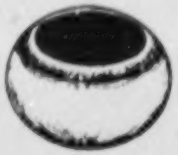
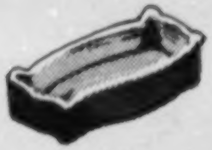


TABLE BOWL


"PILLOW" VASE


BOWL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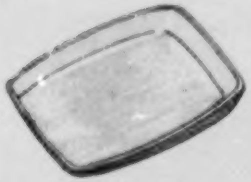
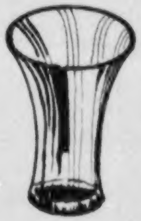
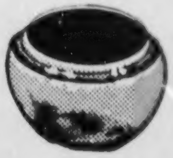

TRAY

GLASS


VASE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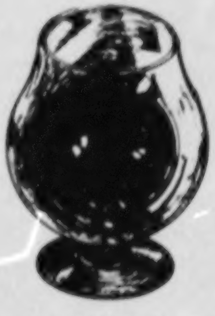
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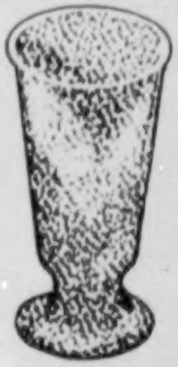
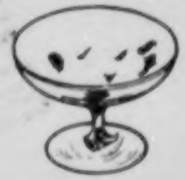
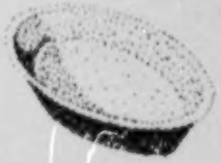

MILK GLASS VASE

PLASTIC


PEDESTAL

PAPER MACHÉ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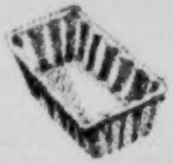
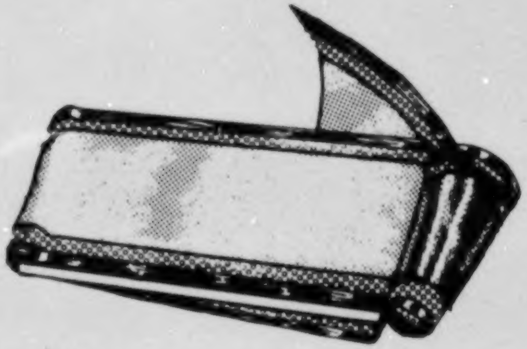
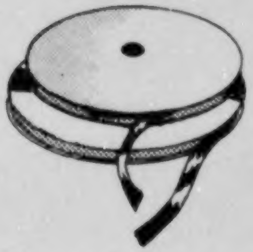

CUP

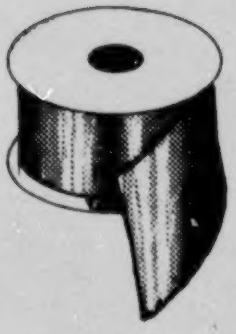
FLORIST SUPPLIES



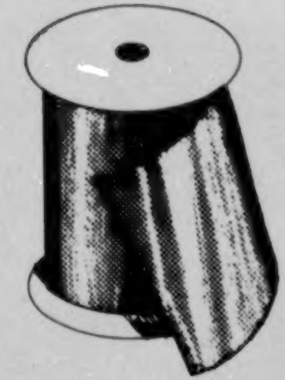
WIDE NET RIBBON



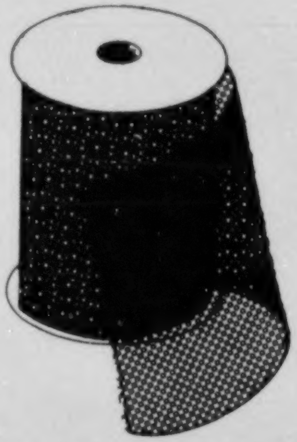
CORSAGE RIBBON



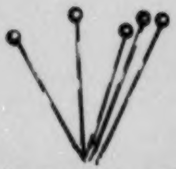
POT TIE
RIBBON



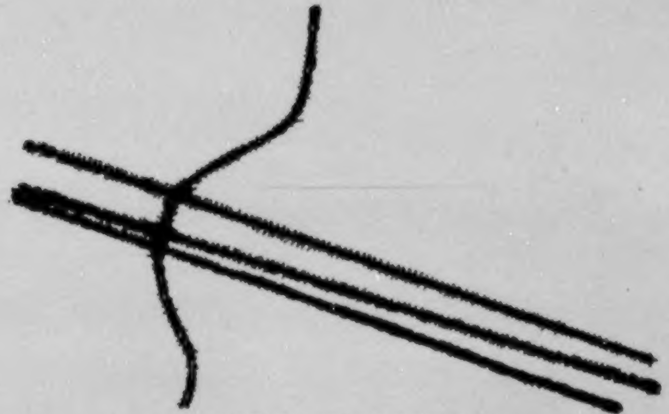
WIDE SATIN
RIBBON



WIDE NETTING

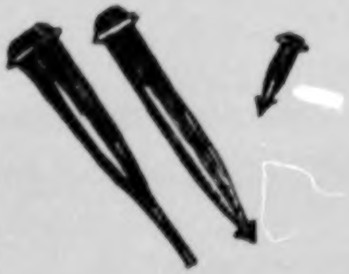


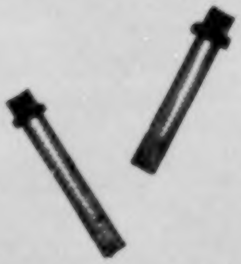
CORSAGE PINS



PIPE CLEANER

FLORIST SUPPLIES


WATER PICKS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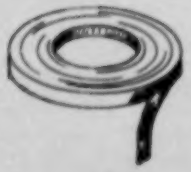
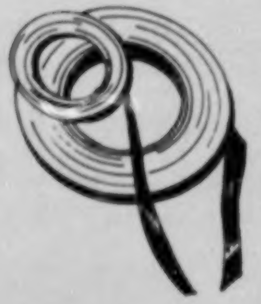
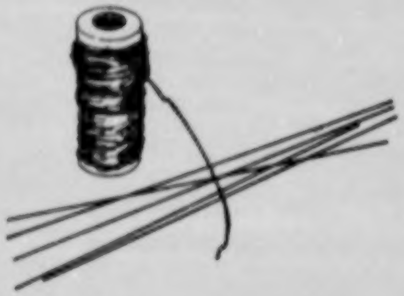
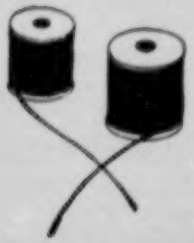
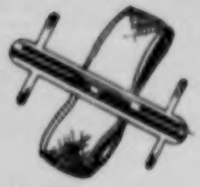

WATERPROOF ADHESIVE TAPE


FLORATAPE


WIRE


THREAD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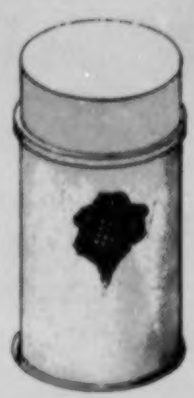
SPRAY PAINT

Vocational Instructional Services
Agricultural Education

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CVAE AND VEH HORTICULTURE

Unit L: Floral Arrangements

Topic 2: Designing Floral Baskets, Vases, and Miscellaneous Tributes

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

Several laboratory exercises are included in the information provided in this topic.

1. Introduction

The designing of flower arrangements includes a consideration of the surroundings in which the arrangement will be placed. It also includes the selection of an appropriate container, flowers, foliage, and accessories. Arranging or designing is the combining of ideas and materials to give a pleasing effect.

2. Principles of Flower Arrangements

Flower arrangements are more pleasing to the eye when certain basic principles are followed. The basic principles in arranging flowers are (1) design, (2) balance, (3) scale, (4) harmony, (5) focal point, (6) accent, (7) rhythm, (8) repetition, and (9) unity. A discussion of each is given.

Design

The design is the over - all shape of the composition. It is the relationship between flowers, foliage, container, and surroundings. There are five elements to consider in designing an arrangement;

1. Line - This is the underlying skeleton that holds the arrangement together. All arrangements are started with a linear piece of material about which other materials are added. The line may be curved, perpendicular, or horizontal. A curved line gives a feeling of motion. Vertical lines express dignity and aspiration. A horizontal line gives a feeling of tranquility and repose.

2. Form - This refers to the shape of the flower arrangement. Flower arrangements can taken on many forms such as a triangle, a horizontal line, a vertical line, an L - shaped line, an inverted T - line, and a curve.

   Triangular designs are the most popular and may be equilateral (all sides equal), isosceles (two sides equal), or asymmetrical (no two sides equal). Florists classify triangular designs as right angle, symmetrical, or asymmetrical.

3. Pattern - The outline in which a design projects against a space is the pattern. It may be either linear or massed.

4. Texture - This is the surface appearance of the materials used. Orchids and hybrid - tea roses are fine textured, while zinnias and marigolds are coarse. Texture of the container should harmonize with the flowers and foliage.

5. Color - The color of the flowers is the principal reason for the popularity of flowers. The colors make a flower arrangement interesting and have a psychological effect on people. Complementary colors in an arrangement should be placed opposite to one another.

Balance

Balance refers to stability. If an arrangement appears to be about to topple over, it gives the appearance of being unstable. Just as people have the urge to straighten a picture which is askew, they have the urge to rearrange an unbalanced design. Since unbalanced designs create a dissatified feeling, only balanced designs should be used.

Visual balance or weight is determined by the size of the materials, the distance from the established line or focal point, and the lightness or darkness of the plant materials.

Arrangements which can be divided into two equal parts by a line down the center are formal or symmetrical designs. Those which cannot be so divided are informal or asymmetrical designs. Asymmetrical designs are made up of unequal parts. Symmetrical designs are made up of equal parts. However, it is important to understand that both of these designs are balanced.

Rhythm

Rhythm is the movement of the eye along the lines produced by the arrangement. The eye movement can be organized and rhythmic, or it can be restless and disturbing and lacking in rhythm.

Rhythm may be attained in several ways: through repetition of shapes, forms, or lines; through a progression of small, medium, and large flowers; through a progression of color from light to dark, or dull to bright; and through a continuous straight or curved line.

Scale and Proportion

Scale is the relationship in size of one part of an arrangement to another part. Size of flowers, size of container, amount of foliage, and background may be used to obtain the proper scale.

Proportion refers to the size of the arrangement in relation to the space it is to fill. Flowers varying greatly in size should not be used in an arrangement. Very small flowers should not be used with large flowers or with a very large container.

This is the point of emphasis in an arrangement. Rather than leaving the eye to wander to all parts of an arrangement, the focal point directs the eye to one point. The focal point should be located on the vertical axis at the base of the tallest plant material and on line with the rim of the container. The focal point is achieved by placing the largest flowers or the strongest colors at the point.

Harmony

All parts of the arrangement should complement one another and should blend in such a way to enhance the beauty of the arrangement. Both color harmony and texture harmony should be considered.

Accent

This refers to emphasis. Contrast is used to acquire accent. Different colors, sizes, and textures of materials are used in an arrangement to produce contrast. The focal point may be the point of greatest accent.

Repetition

The repeated use of a certain flower, such as a rose, will provide repetition. It also can be accomplished by the repeated use of a certain color of flower or certain object, such as a pine cone.

Unity

Unity is acquired by fitting together all of the parts to make one arrangement. An example of a lack of unity would be an arrangement with red flowers at the top and white flowers at the bottom of an arrangement. This would give the impression of more than one design.

3. Designing Home and Hospital Arrangements

These arrangements are the most popular items in retail flower shops. The principles of good arrangement and elements of design are the same for all arrangements for these purposes. The design normally will be one of those shown in the following transparency.

Transparency No. 1

Although all of the designs are shown, some designs are more popular than others. The five most often used by florists are vertical, horizontal, symmetrical triangle, right angle, and asymmetrical triangle. Examples of these are shown in transparencies numbers two through six.

Transparency No. 2

Materials used in the vertical design were 6 pieces of Baker fern, 6 spikes of gladiolus, a pedestal type container, foam, and tape.

Steps used to prepare the design are as follows:

Step 1 - Preparing the Container - Select a pedestal type container. Place a holding device (foam) in the container. Tape the holding device to the container.

Step 2 - Establishing the Lines - Cut one gladiolus spike about 1 1/2 to 2 times the height of the container. Place the spike vertically in the center of the holding device.

Step 3 - Establishing the Focal Point - Detach three large blossoms from a spike and center them near the rim and at the front of the container.

Step 4 - Filling-in - Fill in with several spikes approximately 2/3 the length of the original spike. Add Baker fern around the edge of the container. To finish the design and to hide the tape, fill in the back of the container with Baker fern.

An analysis of the design reveals the following factors:

1. The height of the tallest flower is about 1 1/2 times the height of the container.
2. The focal point is made with three large gladioli blossoms. These are put in the center at the rim of the container.
3. Only one color is used in this design.
4. Unity is achieved by the use of only one kind of flower in the design.

Because it is not designed to be viewed from all sides, the vertical design should not be used as a centerpiece unless completed on the back side.

Transparency No. 3

Materials used in the arrangement were 6 pieces of Baker fern, 6 pieces of cattails, 6 pieces of wheatstraw, 6 stems of yellow pompons, 6 stems of bronze pompons, low flat container, foam, and tape.

Steps used to prepare arrangement were as follows:

Step 1 - Preparing the Container - Select a low shallow container. Place a holding device (foam) in the center of the container. Secure the holding device with tape.

Step 2 - Establishing the Lines - Place a stem of pompons in the center of the holding device - make sure it is perpendicular. Place stems of pompons of the same length horizontally on the opposite ends of the container.

Step 3 - Establishing the Focal Points - Use three pompons to form a focal point on each side of the arrangement. These are placed at the base of the perpendicular flower.

Step 4 - Filling-in - Fill in the arrangement. Use two different colors of pompons, Baker fern, dried cattails, and wheatstraw.

An analysis of the design is given below:

1. Balance is achieved by using about equal numbers and sizes of flowers on all sides of the arrangement.
2. This design is made to be viewed from all sides.
3. Colors are complementary - shades of bronze and yellow.
4. The larger and darker colored flowers are placed toward the bottom.
5. Repetition is achieved by a mixing of light and dark colors.

This design is particularly useful for dining rooms or coffee tables, because it is low and can be viewed from all sides.

Transparency No. 4

Six pieces of huckleberry foliage, 12 pink carnations, 12 heather (rose-pink), pedestal - type container, foam, and tape were the materials used in arrangement.

The steps to prepare arrangement are shown below:

Step 1 - Preparing the Container - Select a container (a pedestal type container is used here). Place the holding device (foam) in the container. Tape the holding device to the container.

Step 2 - Establishing the Lines - Use three stems of heather. The vertical piece should be about 1 1/2 to 2 times the height of the container. Place two stems opposite each other and at right angles to the first. The width must be less than twice the height. The tallest flower is also the longest.

Step 3 - Establishing the Focal Point - Place the largest carnation at the front of the container and near the rim for the focal point.

Step 4 - Filling-in - Fill in with additional heather and carnations. Add a small amount of huckleberry. Be sure the triangle is balanced.

From an observation of the arrangement, one should make the following analysis:

1. The larger flowers are placed toward the bottom of the design. The smaller flowering heather is placed toward the outer edges of the arrangement.
2. Colors are monochromatic (shades of red).
3. Unity and repetition are achieved by using heather and carnations all through the arrangement.

The principal uses for this arrangement are office, home, and hospital. It is to be viewed from one side.

Transparency No. 5

Materials used in arrangement were 4 pieces of podocarpus foliage, 8 white carnations, 12 red roses, low flat container, foam, and tape.

Preparation of the arrangement was accomplished in the following steps:

Step 1 - Preparing the Container - Use a shallow tray container. Place the holding device (foam) to the right of the center. Secure the holding device with floratape.

Step 2 - Establishing the Lines - Cut one rose stem about 1 1/2 times the length of the container. Place it vertically and to the side of the holding device. If it does not remain straight, it may be necessary to wire the stem. Cut a second rose shorter than the first. Place the second rose at a right angle to the left of the first.

Step 3 - Establishing the Focal Point - Use three large carnations at the joint of the vertical and horizontal lines.

Step 4 - Filling-in - Use more roses and carnations to fill-in. Add podocarpus foliage along the edge and within the arrangment.

One should gather the following conclusion from an analysis of the arrangement.

1. The larger white carnations are placed toward the bottom of the arrangement. The smaller red roses are placed toward the top and outer edges.
2. Colors are complementary.

This arrangement may be used in almost any location in the home or office. It is also often used in hospitals.

Transparency No. 6

Six pieces of Baker fern, 8 yellow snapdragons, 8 purple iris, pedestal-type container, foam, and tape are the materials used in this arrangement.

Steps in preparing the arrangement are as follows:

Step 1 - Preparing the Container - Select a pedestal type container. Place the holding device (foam) in the container.

Step 2 - Establishing the Lines - Make a vertical line 1 1/2 to 2 times the height of the container using a snapdragon spike. Make a second line about 60 degrees from the horizon. The tip of the second spike should be about 2/3 the height of the first spike. Make a third line about 30 degrees below the horizontal line. Put this spike on the opposite side from the second spike.

Step 3 - Establishing the Focal Point - Place three iris at the base of the tallest flower and at the joint of the stems to produce the focal point.

Step 4 - Filling-in - Use additional iris and snapdragons to fill in. Add Baker fern around the edge of the container. Iris should be mixed throughout the design.

An analysis of the arrangement reveals the following:

1. The general effect is one of balance although one side is high and the other is low.
2. The colors used are complementary (yellow and purple).

This design is used for home or hospital and can be viewed from only one side.

4. Wedding Designs

Designs used by the bride and bridal party consist of the bridal bouquet, attendants' bouquets, corsages, and boutonnieres.

Corsages are the most popular items sold in the florist shop. There are four types: shoulder corsages, waist corsages, wrist corsages, and corsages worn in the hair. Shoulder corsages are the most popular of the four types. The shoulder corsage should be worn with the flower (s) facing upward.

Prior to constructing a corsage, one must know how to tie ribbon and be familiar with the different methods in which wire is used.

Transparencies No. 7 and No. 8

1. Hang the ribbon over your left thumb with the long side in front. The ribbon should be about two inches behind the thumb as shown in step 1 of transparency.
2. With your right hand take the long side of the ribbon and loop it under and around the left thumb. Squeeze the ribbon between the left thumb and forefinger as shown in step 2.
3. Grasp the ribbon with the right hand about three inches from the crushed part and make a loop in the air. Bring the ribbon to the spot between the left thumb and forefinger and crush it between the two as in step 3. The ribbon must always be looped "under" so the ribbon will fit between the left thumb and forefinger. Never leave the ribbon flat, but crush it after each loop. Looping over instead of under will make bow tying more difficult.
4. Go down the ribbon three inches and loop it up under. Crush again between the left thumb and forefinger. The first two loops have now been formed as shown in step 4.
5. Three or four more loops are made in each direction until the bow reaches the proper size. Each set of loops should be slightly larger than the previous set. This will give the bow more character. See step 5.
6. Cut another piece of ribbon about eight inches long. Insert this under the first small loop in place of your left thumb. Do this by pulling it down on both sides. You can tie it at the back. This will hold the bow as you have constructed it.
7. Using the two ends of the short piece which you used to tie the bow together fasten the bow to the corsage snugly against the bottom flower and tie securely with the short ribbon ends.
8. Trim off any ribbon ends that seem too long, and your corsage is finished.

Roses, carnations, standard chrysanthemum, and orchids are the most commonly used flowers in shoulder corsages. The procedure for making a shoulder corsage is shown in the following transparency.

Transparency No. 9

Materials used in the construction of the carnation corsage are 2 stems of Baker fern, 4 carnations, wire (no. 24), floratape, 1/2 - inch ribbon, and corsage pin.

Steps in construction are as follows:
Step 1 - Wiring and Taping - Wire four carnations. Use the piercing method. Wrap the wire with floratape.

Step 2 - Adding the Backing - Tape a small piece of Baker fern to each wired carnation.

Step 3 - Assembling - Join the four carnations, one at a time, to form a line design.

Step 4 - Finishing - Bend the corsage so as to form the desired shape. Add a bow in the center of the corsage and add a pin.

The carnation corsage may be straight or curved by shaping. Natural colors, green and white, were used.

Transparency No. 10

One cattleya orchid, 1 water tube, netting, 4 pieces of no. 24 wire, floratape, and corsage pin were used in constructing this corsage.

The following steps are used to construct this corsage:

Step 1 - Wiring and Taping - Place a wire vertically up the stem of the flower but not entirely through the flower. Place a second wire horizontally through the base of the flower. Bend both ends down along the stem. Wrap the wires with floratape.

Step 2 - Adding the Water Tube - Cut the wired stem to two inches and place in a water tube. Wrap with floratape.

Step 3 - Adding the Backing - Prepare three net puffs and place one to the back and one to each side of the orchid. Tape the net puffs in place.

Step 4 - Finishing - Make final placement of net puffs. Add a bow as close to the orchid as possible. Add a corsage pin.

The focal point is the orchid, and the netting and ribbon give a finished look. Colors used are shades of violet.

Transparency No. 11

Materials used in constructing the rose corsage are 1 stem of Baker fern, 5 roses, no. 24 wire, floratape, 1/2 - inch ribbon, and corsage pin.

The procedures for constructing the corsage are given below:

Step 1 - Wiring and Taping - Wire each rose through the base; see transparency No. 8. Tape the wired flower with floratape.

Step 2 - Adding the Backing - Tape a small piece of Baker fern to the base of each rose with floratape.

Step 3 - Assembling - Place each taped and backed rose together to form a triangular or shield-type design. Each flower must be tied, wired, or attached to the others individually.

Step 4 - Finishing - Place the largest rose at the base of the corsage. Add foliage at the base. Add the bow and the pin.

The rose corsage is usually of a triangular design. The smaller buds are placed in the upper portion of the design. Complementary colors of orange and green are used.

The Boutonniere

Transparency No. 12

Men in wedding parties wear boutonnieres. The procedures for making a boutonniere are as follows:

Step 1 - Wiring and Taping - Wire one carnation by placing a wire horizontally through the calyx then bending the wire ends down and around each other.

Step 2 - Adding the Backing - Tape a small piece of Baker fern to the carnation. Tape the entire stem and curl. Add a boutonniere pin.

5. Funeral Designs

The most frequently used funeral designs may be classified into six categories: (1) baskets, (2) sprays, (3) wreaths, (4) casket covers, (5) vases, and (6) special designs. Each category is constructed with different materials, and different construction techniques are required.

Funeral Basket

A funeral basket may be constructed in a basket or in a paper mache' container. Most any flowers or foliage may be used in constructing the design, but sharply contrasting colors should not be used.

Transparency No. 13

The materials used in constructing the funeral basket are salal foliage, 12 standard chrysanthemums, 12 pompon chrysanthemums, paper mache' container, 1/2 - inch mesh wire, and 1 1/2 - inch ribbon.

The procedures for preparing a funeral basket are given below:

Step 1 - Preparing the Container - Select a basket (usually of paper mache'). Add 18" of a roll of chicken wire to the container.

Step 2 - Establish the Lines - Use salal to form a symmetrical triangle. Place one standard chrysanthemum at each corner of the triangle.

Step 3 - Filling-in - Add more standard chrysanthemums. Add pompon chrysanthemums as a filler.

Step 4 - Establishing the Focal Point - Add a large bow of ribbon at the front. Center it just above the edge of the container.

This design is in the form of a large equilateral triangle. The large standard chrysanthemums form the major lines, while the smaller pompon chrysanthemums form the background. Lavender and white colors are used.

Sprays

Sprays may be picked or tied. Picked sprays are constructed on styrofoam, foam materials, pine needles, or a sphagnum moss base. With the moss base, the damp sphagnum is placed inside hardware cloth. The flowers are then wired, placed in picks, and inserted into the base. Picked sprays last longer when plant materials are placed in the wet base or in water picks.

Tied sprays are made by tying the materials together without a frame. Sometimes a bamboo stake is used for support. Tying requires skill and is more difficult for most designers. Wreaths may be picked. The picked type of wreath with a styrofoam base is the most popular.

Transparencies No. 14A and No. 14B

Materials used in the spray were 24 pieces of salal, 24 gladioli, 8 stems of pompons, a styrofoam board (1" x 2 1/2" x 16"), easel, 24 water picks, and ribbon (1").

Steps in preparing the spray are as follows:
Step 1 - Selecting the Holding Device - A 1" x 2 1/2" x 18" piece of styrofoam is used as the holding device. A wire easel is used as a stand.
Step 2 - Forming the Background - Use short branches of salal to form the triangular - or shield - shaped background.
Step 3 - Preparing the Gladioli Spikes - Cut the top of each gladiolus spike back to the first bud which shows color. Cut to a length slightly longer than the background. Place each gladiolus spike in a water pick.
Step 4 - Placing the Gladioli Spikes - Place the gladioli spikes into the styrofoam so as to face upward and outward. The triangular shape is maintained.
Step 5 - Filling-in - Fill in the design with white pompons.
Step 6 - Finishing - Make sure that the gladioli and pompons are facing slightly upward and outward. Add a large bow ribbon.

The bow forms the focal point in this design, and the eye is directed upward and outward. Complementary colors of white and pink were used.

Illustrations of the casket covers, vases, and special designs are not given.

6. Decorating a Flowering Pot Plant

Colored foil and ribbon are normally used to decorate a flowering pot plant. The foil and ribbon colors should match either the flower or foliage colors.

Transparency No. 15

Steps in decorating a flowering pot plant are given below:
Step 1 - Cutting the foil - Foil is cut from a roll to form a square piece, and the pot is placed in the center of the square.

Step 2 - Crimping the foil and tying ribbon - The foil is crimped around the pot rim to hold it in place. The bow is tied from ribbon that is 1 1/2 to 2 inches wide, and is wired to a wooden pick. The pick is inserted through the foil into the soil at the pot edge.

Materials used are a flowering pot plant, foil, ribbon, wire, and a pick.

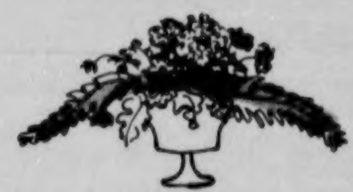
The bow is placed on the most attractive side of the plant, which is sometimes called the "face" of the plant.

The information for this topic was taken from the reference listed below.

Reference:

"Retail Flower Shop Operation and Management", a student handbook, The Pennsylvania State University, College of Agriculture, University Park, Pennsylvania.

BASIC DESIGNS FOR HOME & HOSPITAL ARRANGEMENTS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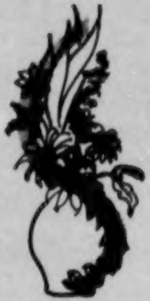
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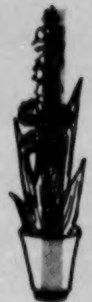
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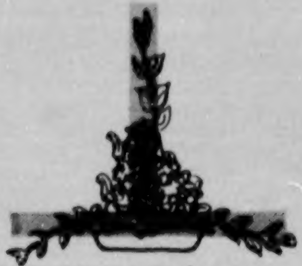
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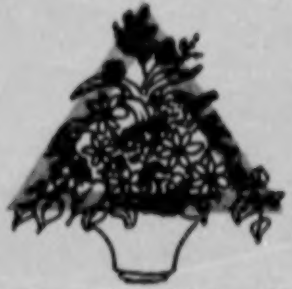
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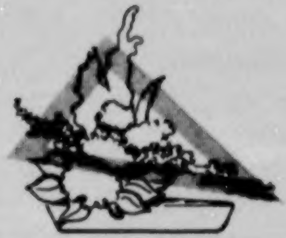
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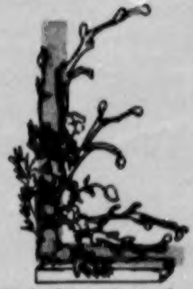
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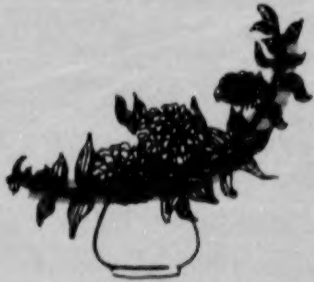
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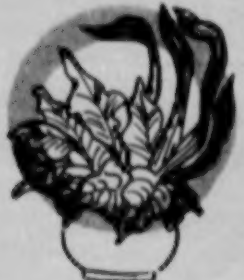
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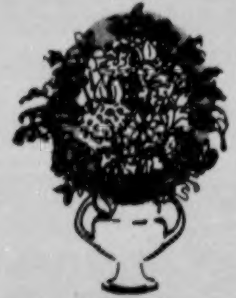
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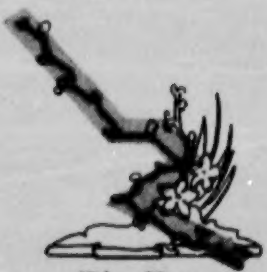
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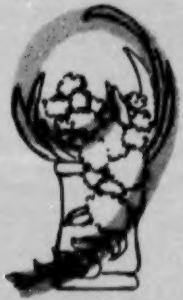
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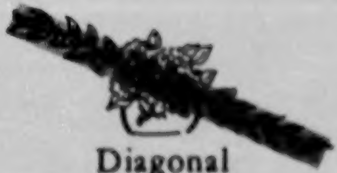
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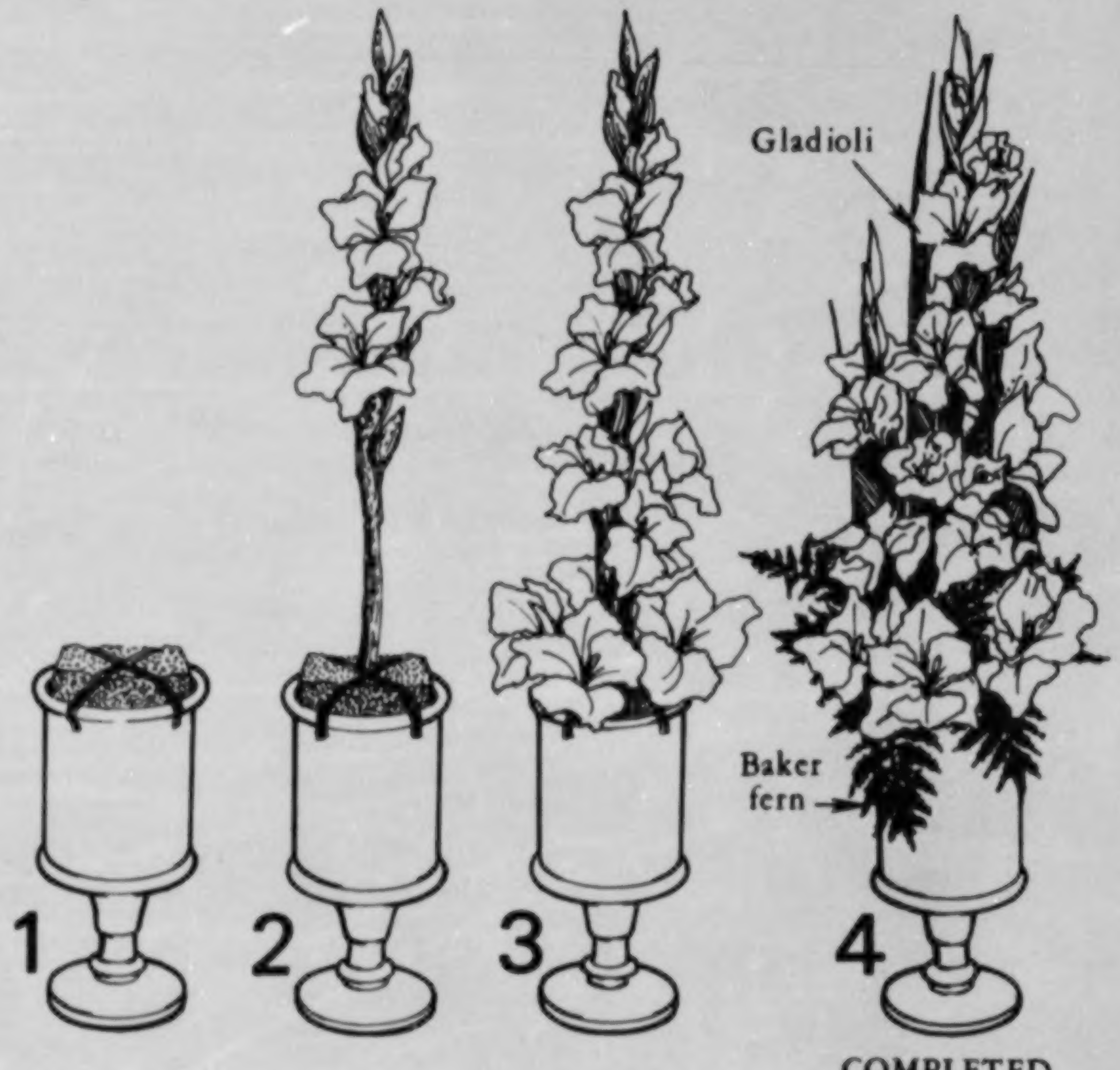
VERTICAL DESIGN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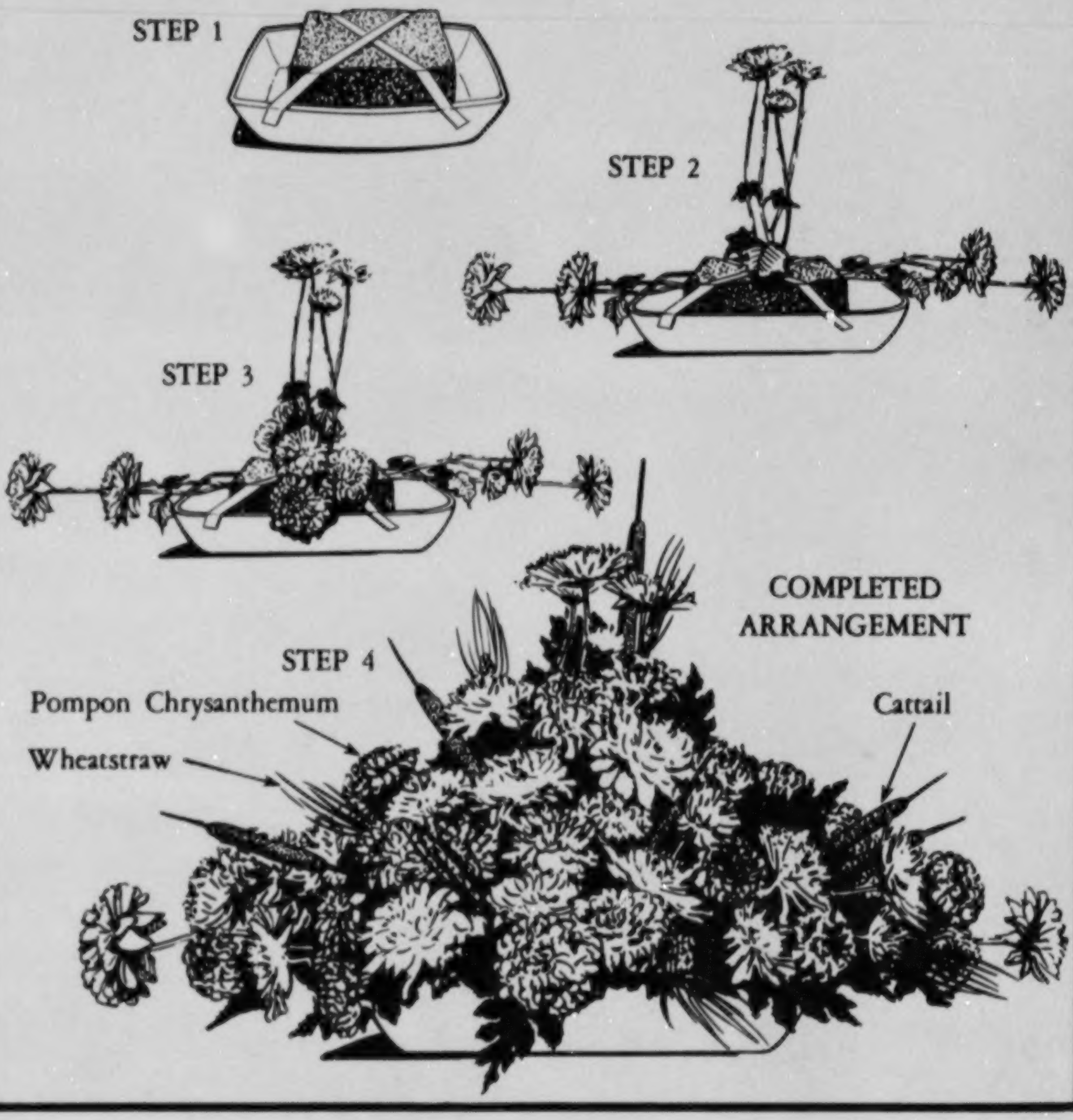
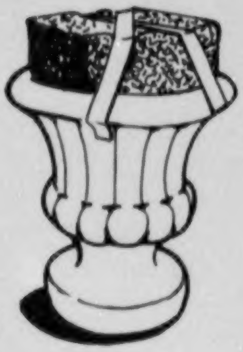
Baker fern
1
2
3
4
COMPLETED ARRANGEMENT

HORIZONTAL DESIGN


STEP 1
STEP 2
STEP 3
STEP 4
COMPLETED ARRANGEMENT
Pompon Chrysanthemum
Wheatstraw
Cattail

SYMMETRICAL TRIANGLE DESIGN



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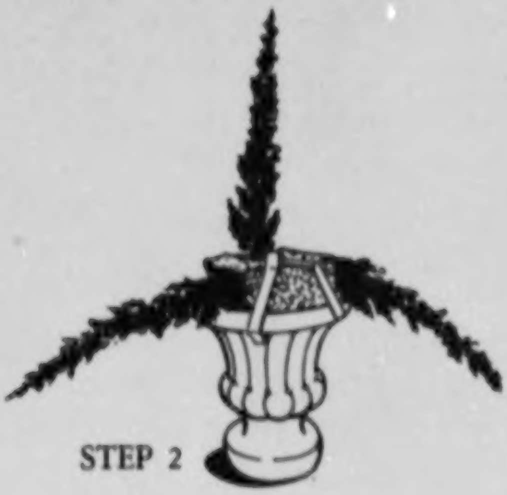

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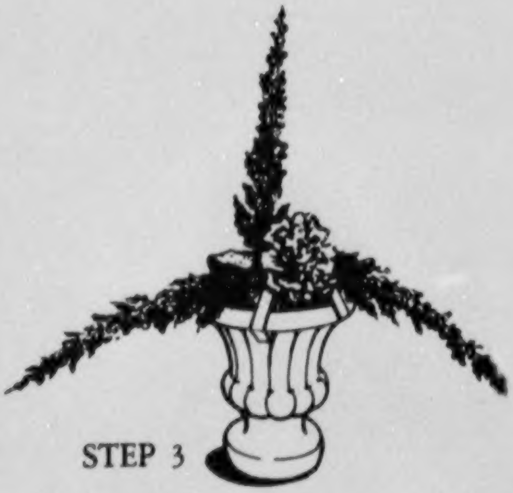

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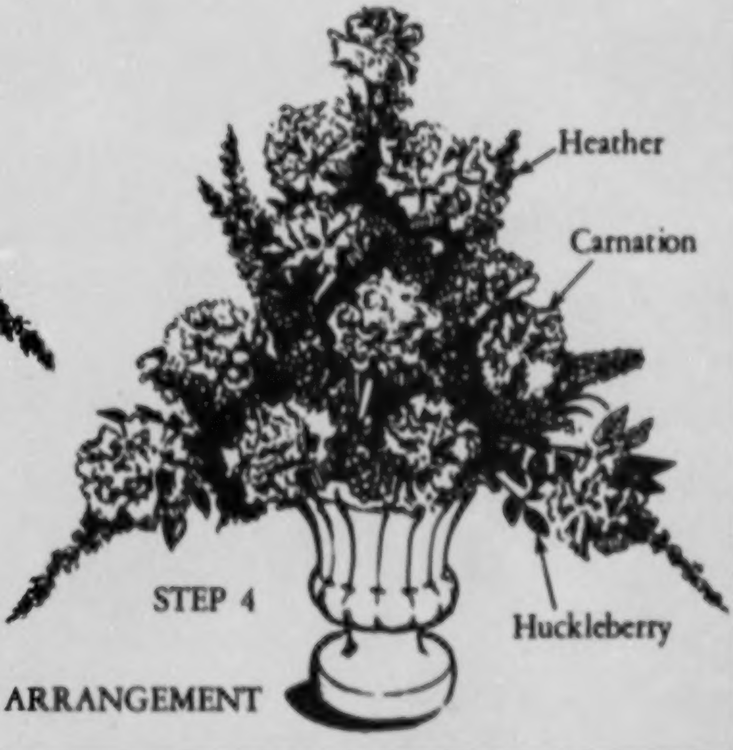
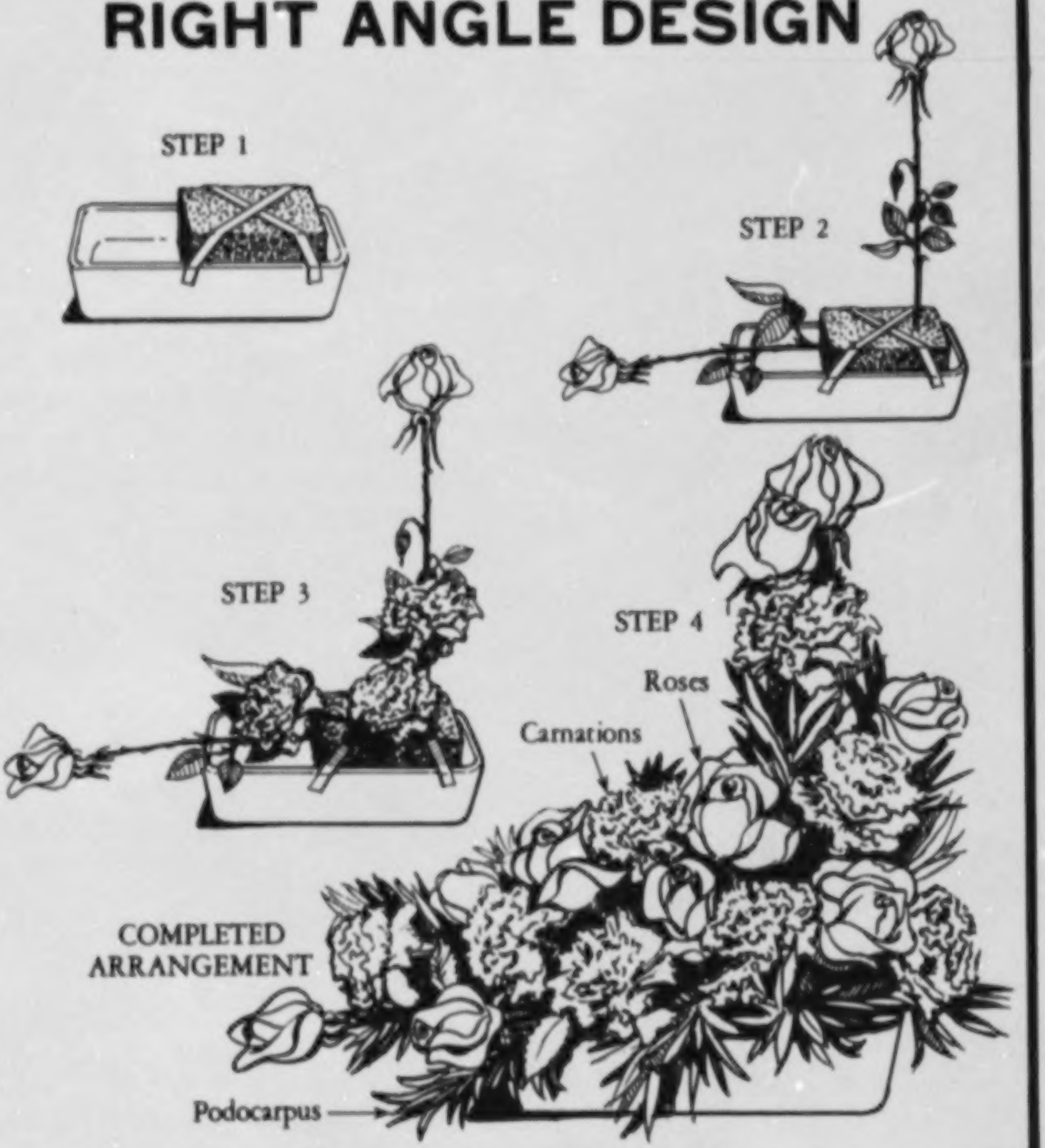

Heather
Carnation
Huckleberry

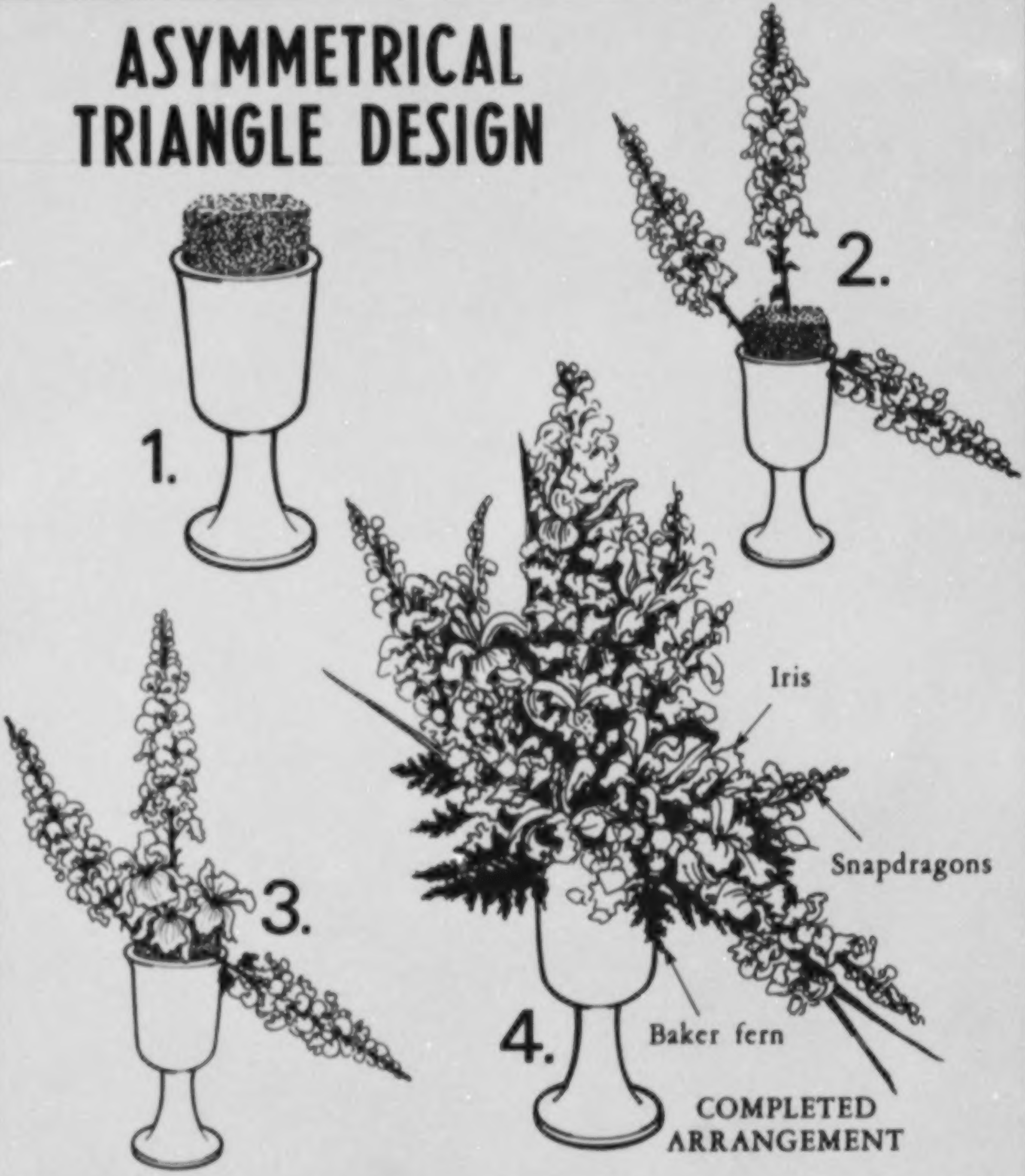
STEP 4

COMPLETED ARRANGEMENT

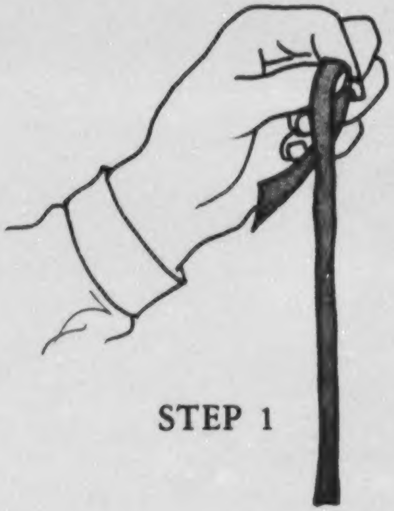
RIGHT ANGLE DESIGN


STEP 1
STEP 2
STEP 3
STEP 4
Roses
Carnations
COMPLETED ARRANGEMENT
Podocarpus

ASYMMETRICAL TRIANGLE DESIGN


1.
2.
3.
4.
Iris
Snapdragons
Baker fern
COMPLETED ARRANGEMENT

STEPS IN TYING RIBBON



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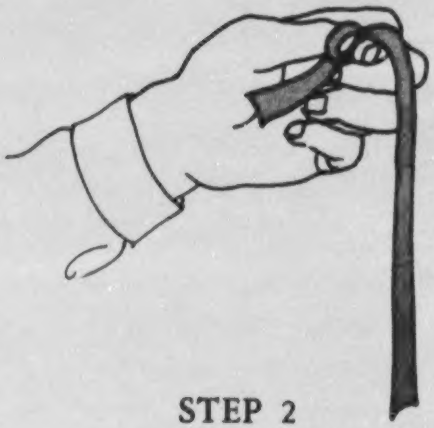

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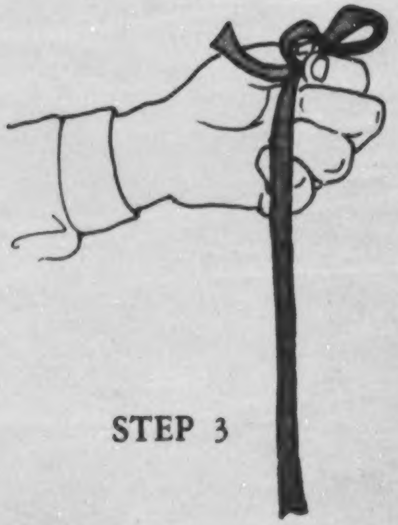

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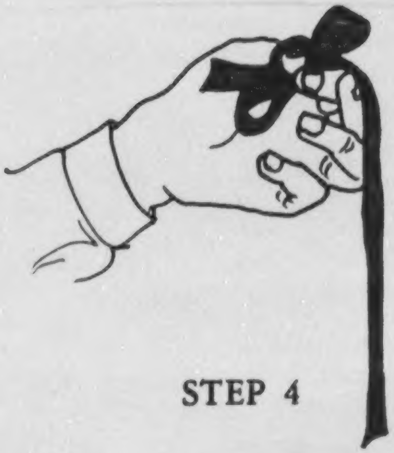

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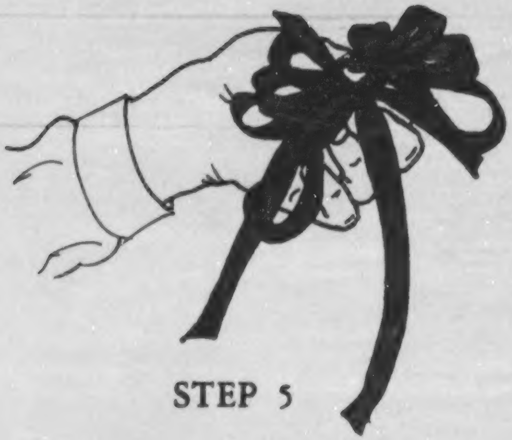
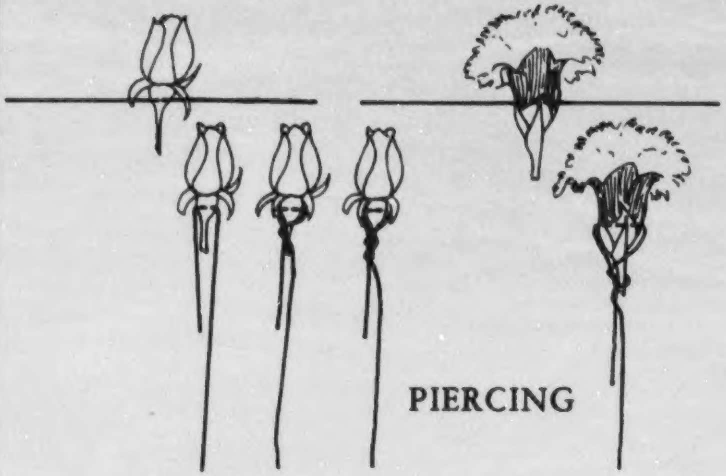
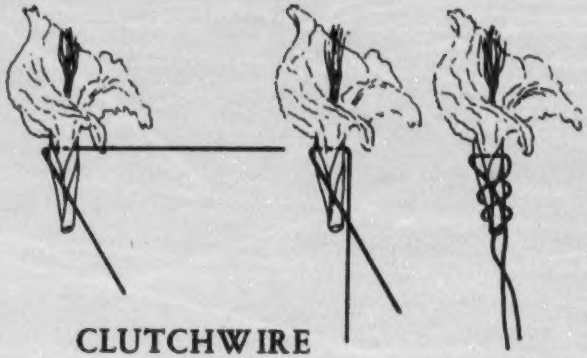


STEP 5

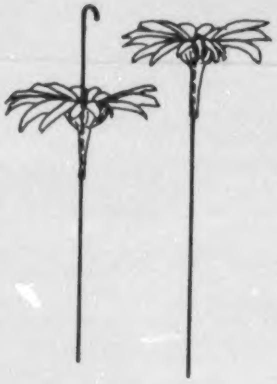
METHODS USED TO WIRE FLOWERS



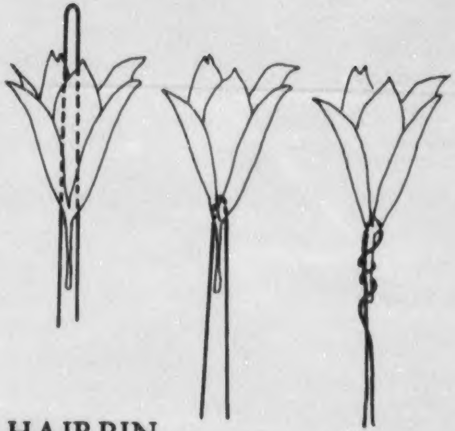
PIERCING



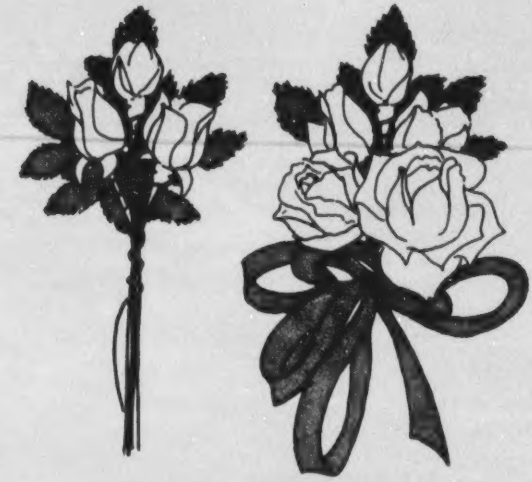
CLUTCHWIRE



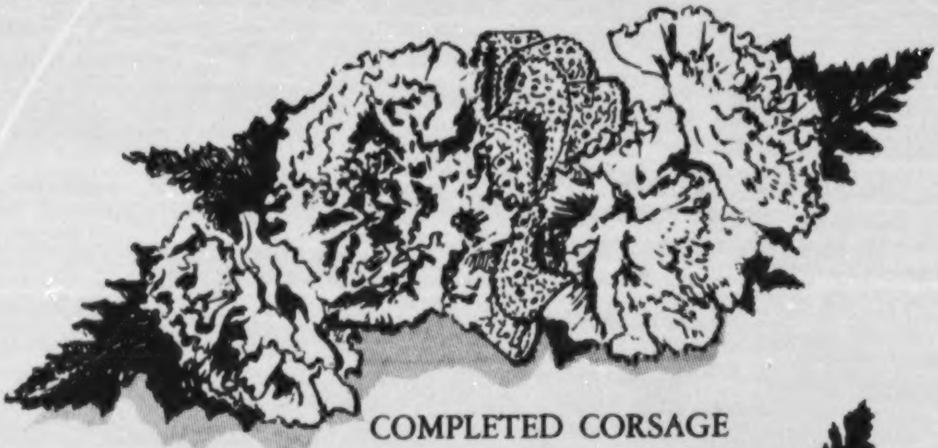
HOOKWIRE



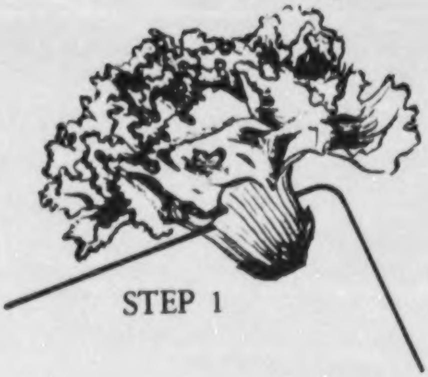
HAIRPIN



THE CARNATION CORSAGE



COMPLETED CORSAGE



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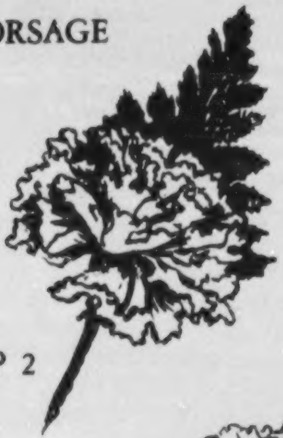

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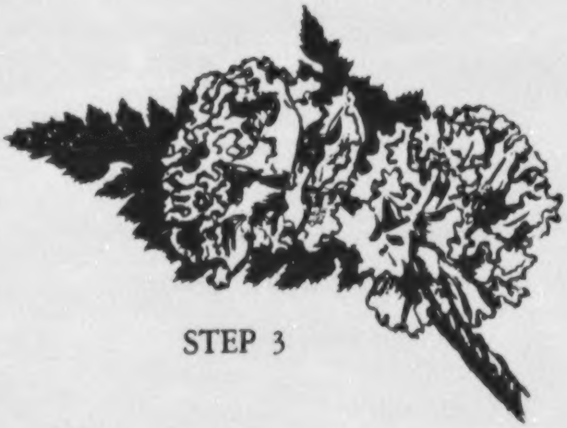

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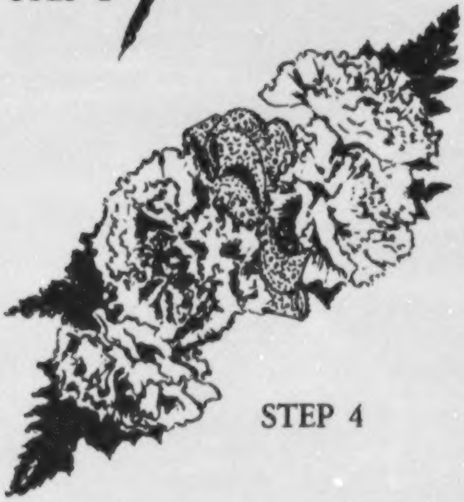
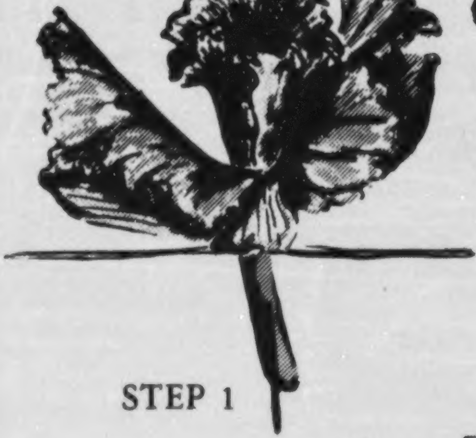
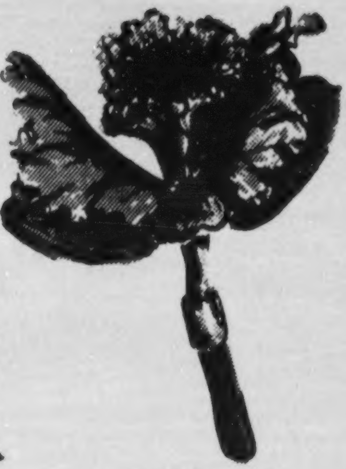


STEP 4

CATTLEYA ORCHID CORSAGE



STEP 1



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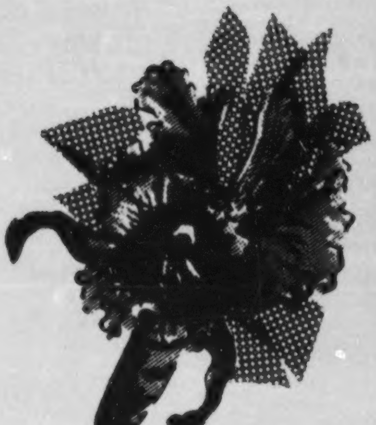

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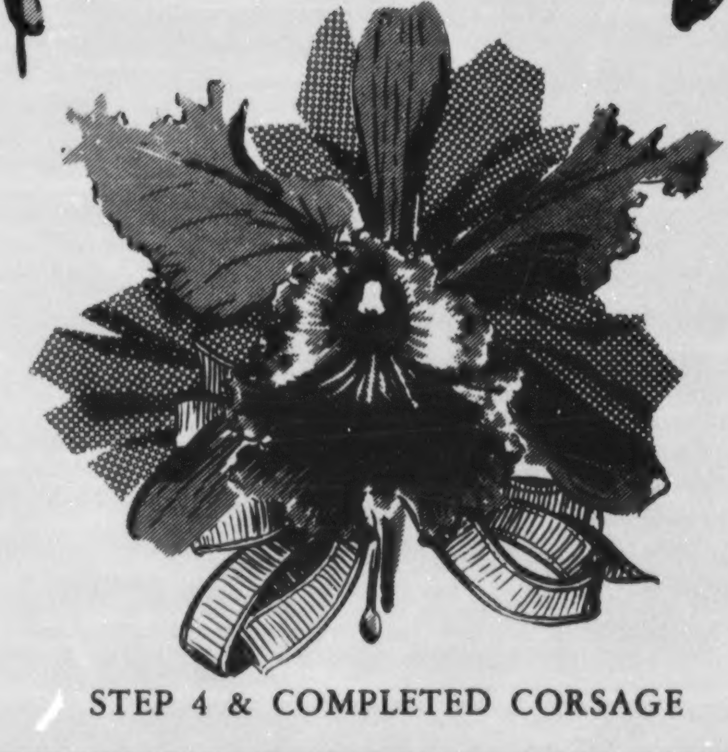
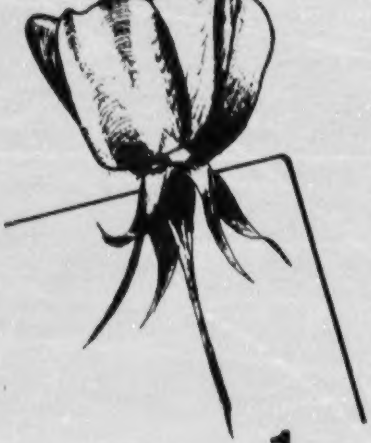


STEP 4 & COMPLETED CORSAGE

ROSE CORSAGE



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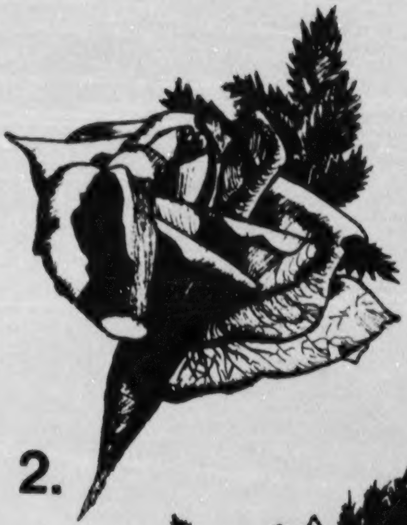

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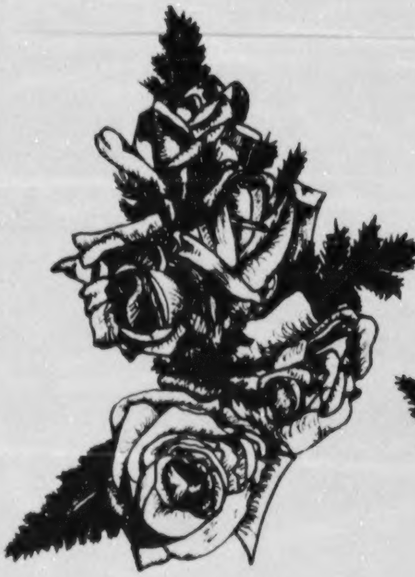

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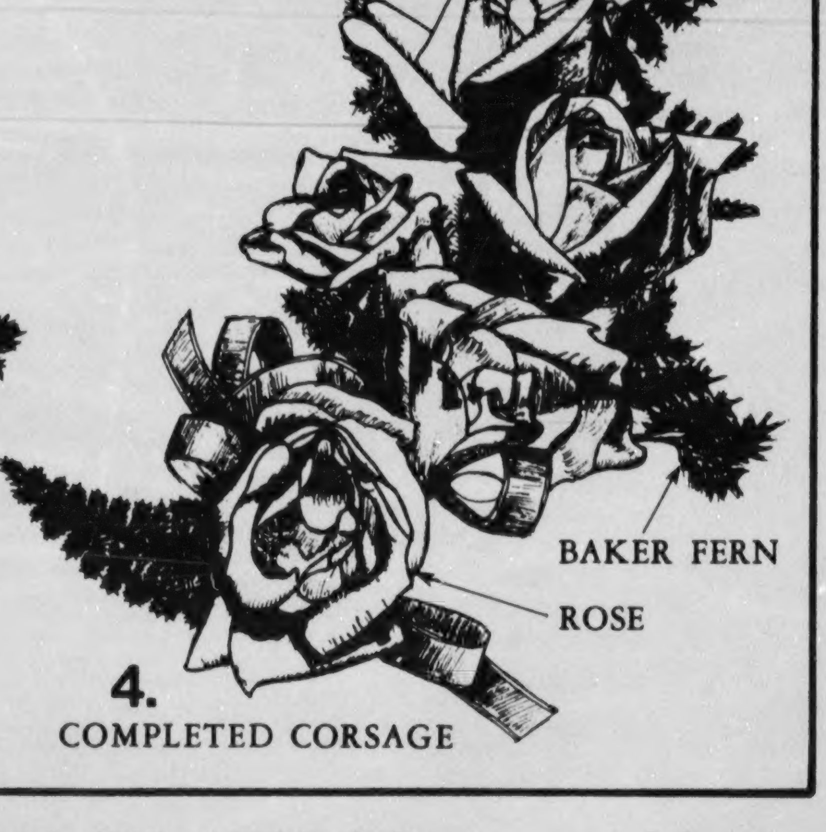
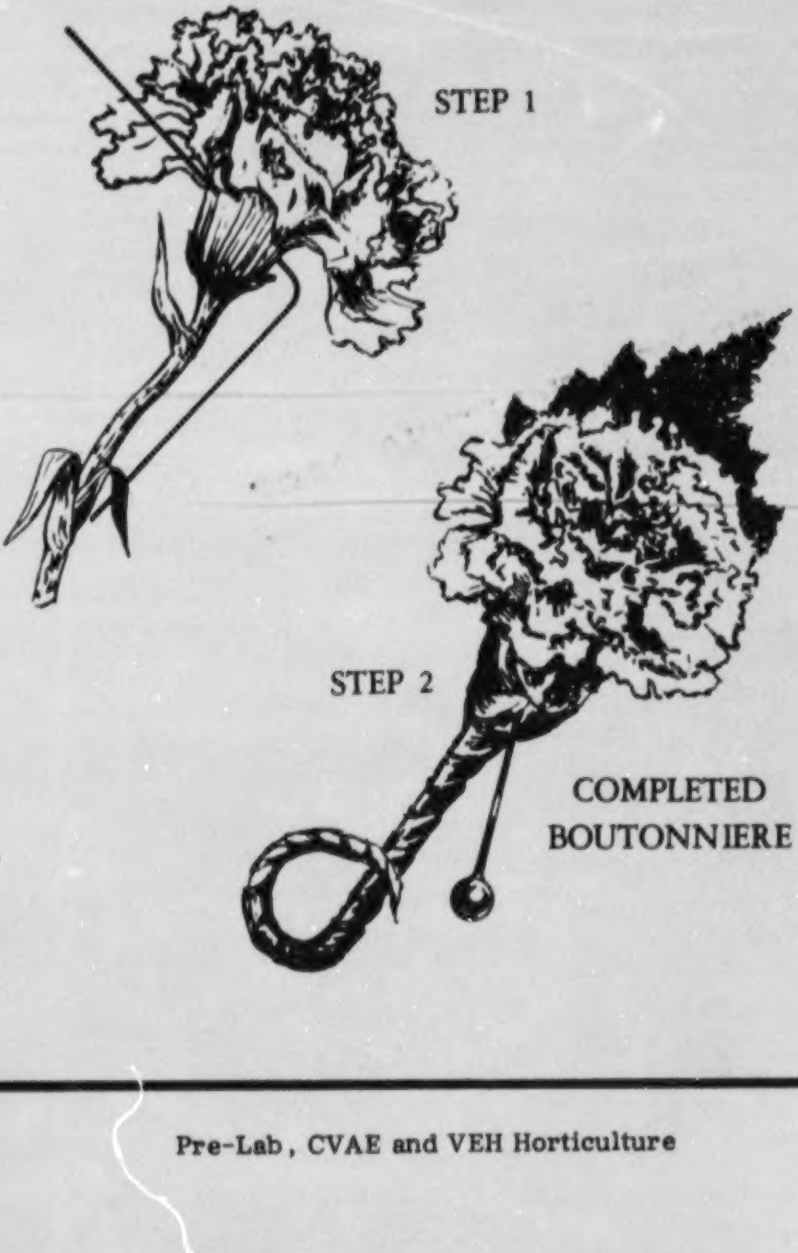

BAKER FERN
ROSE

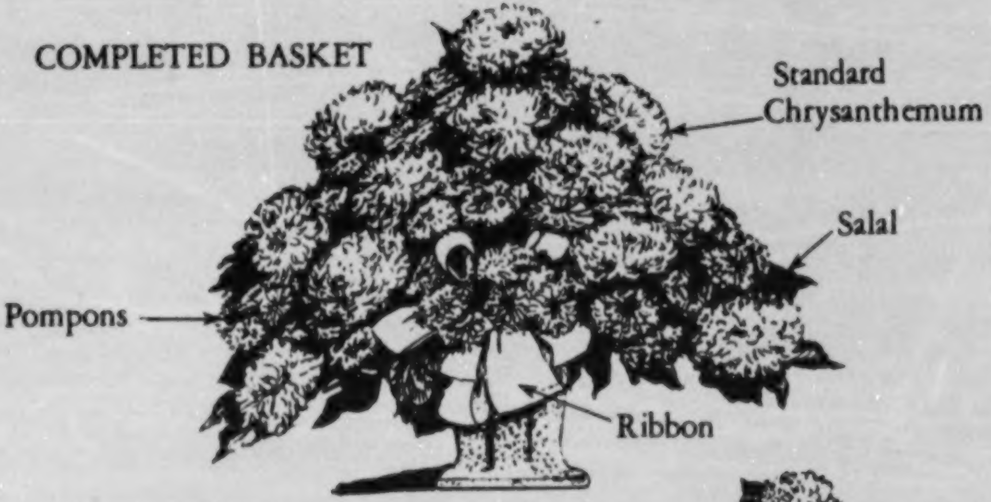
4.
COMPLETED CORSAGE

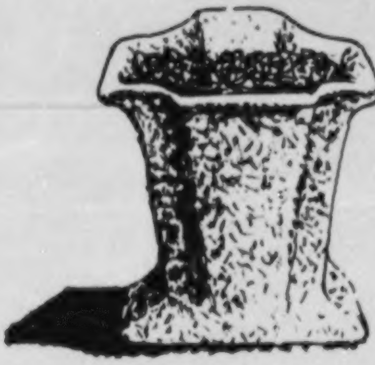
THE BOUTONNIERE


STEP 1
STEP 2
COMPLETED BOUTONNIERE

FUNERAL BASKET

COMPLETED BASKET


Standard
Chrysanthemum
Salal
Pompons
Ribbon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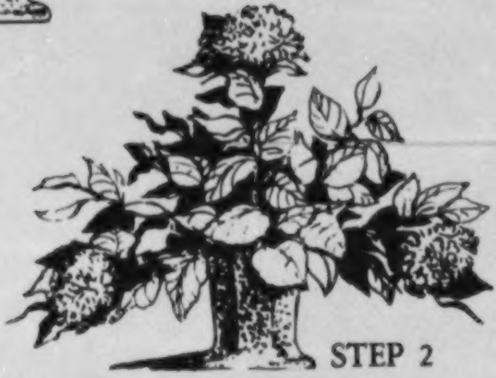
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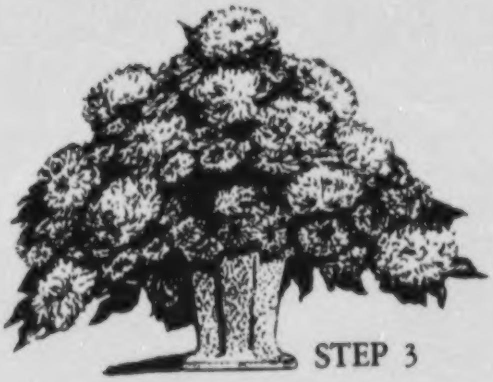
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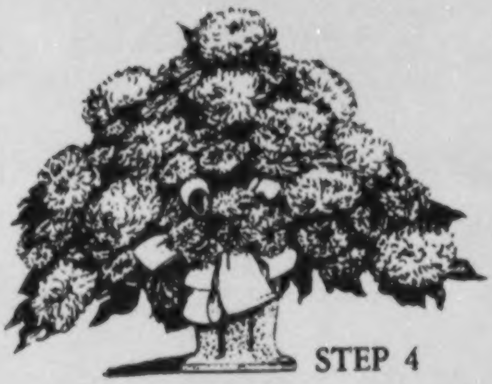
STEP 4

THE FUNERAL SPRAY

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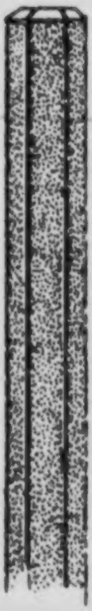

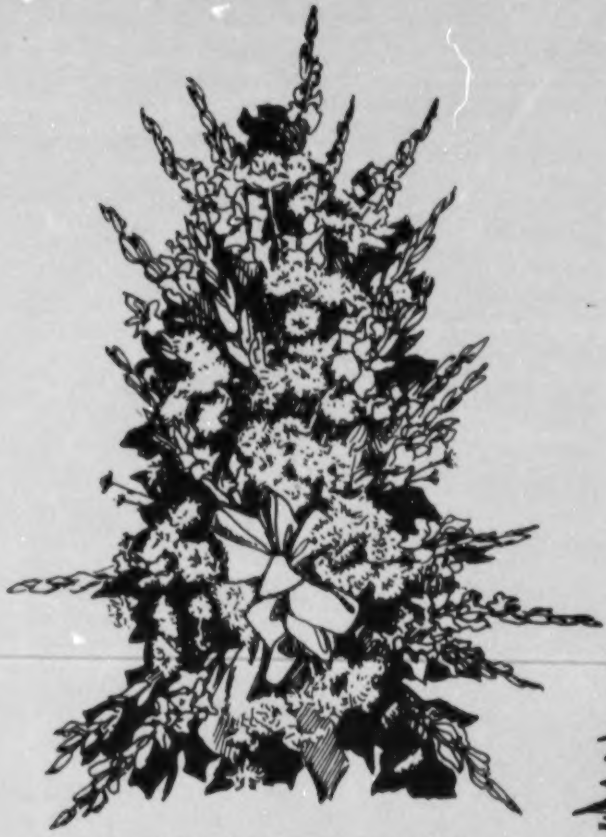

COMPLETED SPRAY

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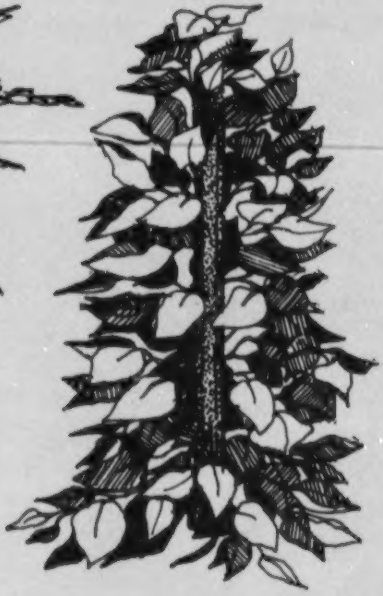
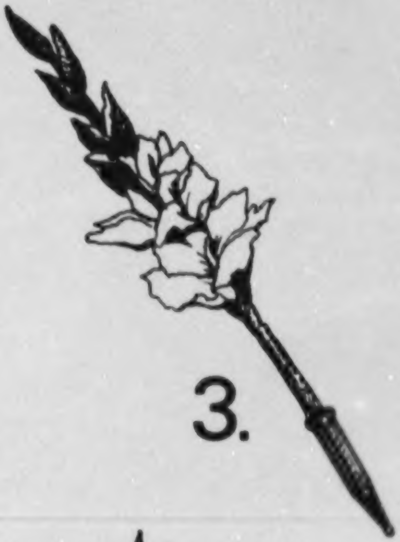


THE FUNERAL SPRAY



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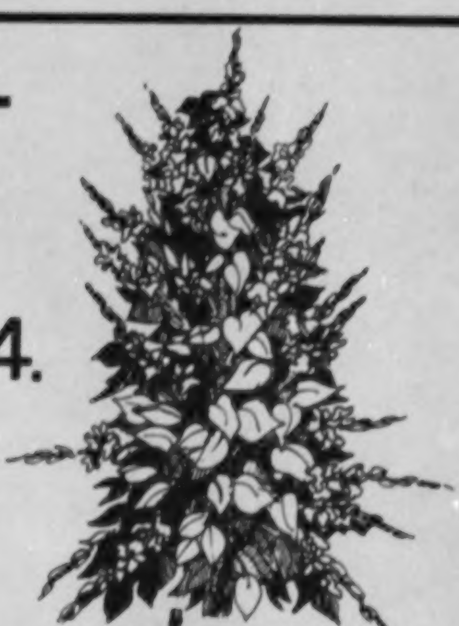

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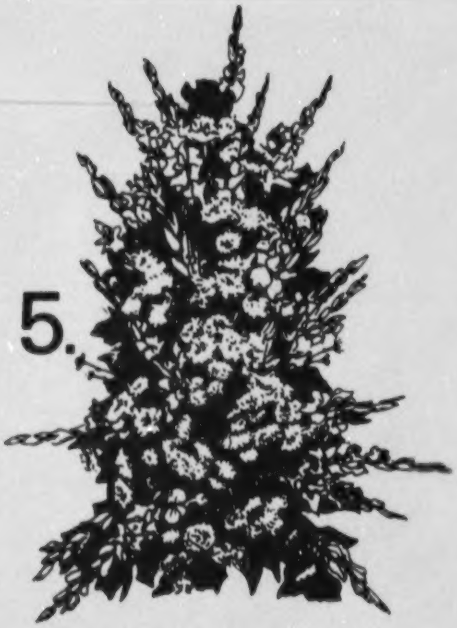

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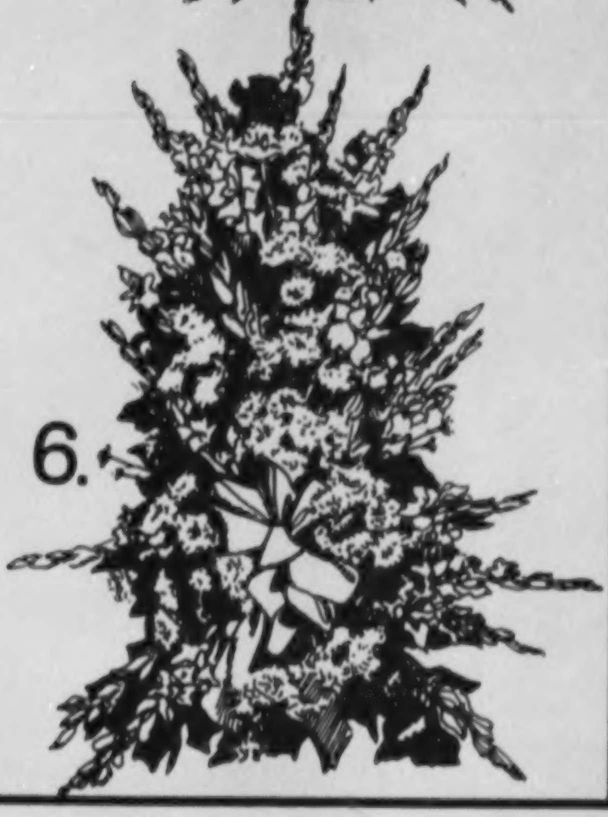
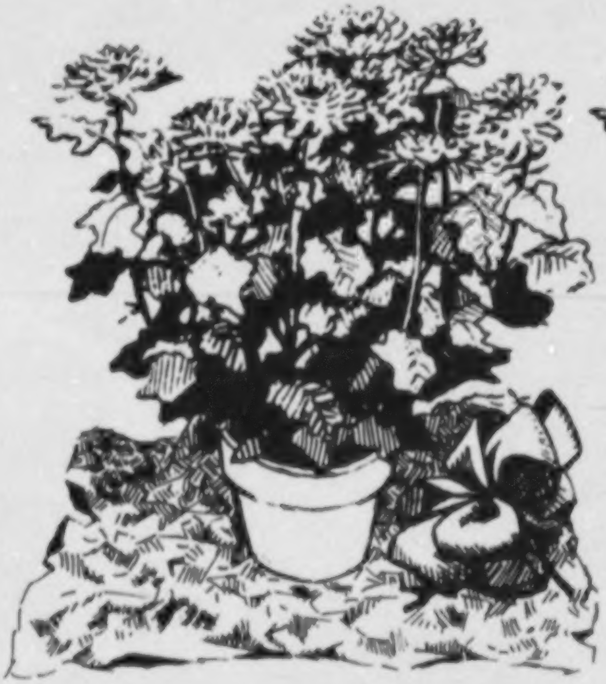
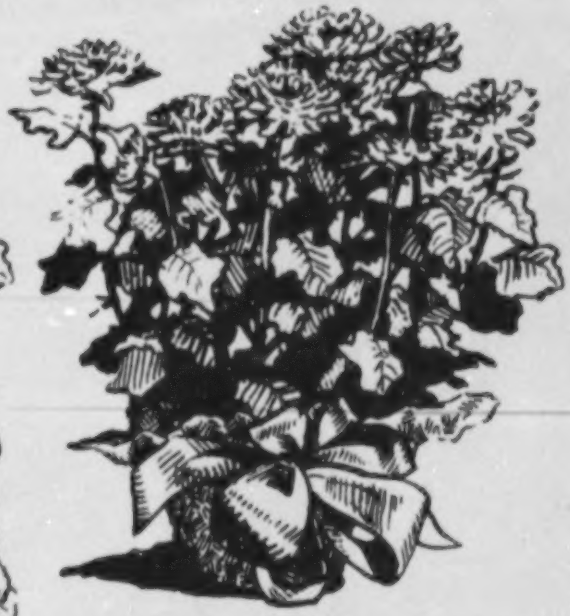


6.

FLOWERING POT PLANTS



STEP 1



STEP 2
COMPLETED POT

CVAE AND VEH HORTICULTURE

Unit M: Greenhouse and Nursery Business Management

Topic 1: Calculating Production Costs

Note: All terms underlined are included in the "Glossary of Terms."

1. Production Expenses

Although this topic deals primarily with a greenhouse operation, a similar procedure could be used by a nursery operator.

Most of the production expenses in a greenhouse operation are fixed. Normally production expenses can be determined by figuring the cost on a square-foot-per-year basis. Since there is only a slight increase in the total production cost when the number of plants produced in a given area is increased, the variable expenses are very small. The expenses are about the same whether 2,000 or 6,000 plants are grown in the same amount of bench space. An increase in the number of plants grown on the same space and selling the plants at a lower price will usually increase profits. However, there are certain limitations.

Recent data on the expense of producing greenhouse crops are not available. At one time, a study was conducted by the Texas Agricultural Experiment Station to determine the production cost for 26 varieties of potted plants. Turnover, plant quality, time required to produce, and cost were the basic considerations in the study. At the time of the study, it was determined that the annual cost per square foot of greenhouse bench space was about $2.60. It is estimated that the present cost would be double this figure, or about $5.20 per foot.

2. Computing Greenhouse Expenses

The following method was used in the study mentioned above and can be used by most greenhouse operators.

Transparency No. 1

Cost per square foot of bench space per year - $5.20

Cost per square foot of bench space per week - ($5.20 ÷ 52) - 10¢

Plants potted in 3 - inch pots and placed on bench, pot-to-pot for 4 weeks, 12 pots per sq. ft. ($\overset{10 \times 4 = 40}{12 \div 40 = 3\ 1/2}$) — 3 1/3¢. At the end of the fourth week, plants were spaced 4 per sq. ft. for remaining 3 weeks. — 7 1/2¢
(3 weeks x 10¢ = 30¢; Cost per plant 30¢ ÷ 4 = 7 1/2¢)

Total bench space cost per plant (.033 + .075 = .0108)	- 11¢
Cost of rooted cutting	- 12¢
Cost of 3 - inch plastic pot	- 06¢
Production cost of finished plant	- 29¢

Transparency No. 2

In a greenhouse where several different crops are grown, it is necessary for the operator to determine the expense of each crop in order to determine if the crop is profitable. This may be determined by dividing the amount of bench space used for a particular crop by the total amount of bench space.

References:

1. "Production Methods and New Markets for Texas Florist Crops", Texas Agricultural Experiment Station Bulletin, B900, 1958.
2. The Ball Red Book, George J. Ball, Inc., West Chicago, Illinois, 1975.

COMPUTING PRODUCTION COST

7 WEEKS REQUIRED FROM PLANTING TO SALE

COST PER SQUARE FOOT OF BENCH SPACE PER YEAR- $ 5.20

COST PER SQUARE FOOT OF BENCH SPACE PER WEEK 10¢

($5.20÷52=10¢)

PLANTS IN 3 INCH POTS FOR 4 WEEKS
cost per plant-3 1/3¢

POTS SPACED FOUR TO SQUARE FOOT FOR THREE WEEKS

3 WEEKS-30¢
(3×10¢=30¢)

COST PER PLANT -7½¢
(30¢÷4=7½¢)

TOTAL COST FOR BENCH SPACE PER PLANT-11¢
(3 1/3¢+7½¢=11¢)

COST OF ROOTED CUTTING-12¢

COST OF 3 INCH PLASTIC POT-6¢

PRODUCTION COST OF FINISHED PLANT-29¢

OVERHEAD EXPENSE PER CROP

CROP	AMOUNT OF BENCH SPACE PER CROP	% TO TOTAL SPACE		TOTAL EXPENSE	EXPENSE PER CROP
COLEUS (1)	500	33.3	×	$7,000	$2,331
FOLIAGE PLANTS (2)	300	20.0	×	$7,000	$1,400
GERANIUMS (3)	500	33.3	×	$7,000	$2,331
BEDDING PLANTS (4)	200	13.4	×	$7,000	$ 938
	1,500 FT.	100.0	×	$7,000	$7,000

CVAE AND VEH HORTICULTURE

Unit M: Greenhouse and Nursery Business Management

Topic 2: Labeling, Pricing, Displaying, and Advertising

Note: All terms underlined are included in the "Glossary of Terms".

1. Labeling and Pricing

Proper labeling and pricing of plants and other materials are essential for a successful nursery or greenhouse operation. Accurate records are also essential.

Transparency No. 1

In a retail operation, all plant materials offered for sale should be labeled in a place that is readily noticeable by the customer. The label should contain the name of the plant and the selling price. Various size and shape labels are available that can be attached to the container or plant with a wire tie. Another method of labeling and pricing plants is to group them according to size, and label and price the plants with a large, single label.

The beginning horticulturist often prices plants too low the first time they are priced. Transplanting cost, price of cuttings, salaries, plant losses, bad debts, unpurchased materials, inventory losses, volume of business, and profits are some of the items that should be considered in determining selling price.

Transparency No. 2

There are two terms used to describe the difference between the grower's cost of an item and its selling price:

1. Mark up - The amount added to the cost to make the selling price. The mark up is expressed as a percentage.

   Cost + Mark up = Selling Price
   75¢ + 75 = $1.50
   The mark up is 100% of cost.
   $\left(\frac{\text{Mark up}}{\text{Cost}} = \frac{.75}{.75} = 100\%\right)$

2. Gross margin - This is determined by dividing the mark up by the selling price. Assume an owner of a garden center is going to price some chemicals that were purchased from a chemical company or wholesaler.

   Vegetable dust - cost - $1.50
   - sellingprice - $2.50
   Mark up = 60%
   $\left(\frac{\text{Cash mark up}}{\text{Selling price}} = \frac{1.50}{2.50} = 60\%\right)$

Mark up and gross margin are often confused. They are the same in dollars and cents, but are never the same percentage. Mark up is figured on cost, and margin is figured on selling price.

Some businesses determine the margin on a particular item based on the number of times the stock is turned during the year. In order to make enough profit on some items (items purchased and not those produced), the number of times an item turns over in stock during the year times gross margin should equal 100.

Example: Assume that the vegetable dust stock turns over twice during the year. $2X \times (\text{gross margin}) = 100$

$$2X = 100$$

$$X = 50\% \text{ gross margin}$$

2. Displaying Merchandise

A grower may have an outstanding selection of high quality plants and plant materials; but if they are not visible to the public, sales will lag. A good market is essential for a successful business. One of the most effective ways of increasing sales is to attractively display items for sale. A desire must be created on the part of the buyer.

Several different kinds of displays may be used. However, the type of merchandise and area available for the display may affect the type used.

Point - of Purchase Display - This type normally consists of tri-plane, peg board tables, special racks, or bins. They are located where they will be seen by the greatest number of people. This type of display is used to merchandise items that are bought on impulse. It permits the displaying of a large volume of merchandise and an opportunity for the customer to handle the item. Customers like to handle the item they contemplate purchasing.

Floor Displays - Floor displays are best for large items or large quantities of small items. They also are particularly good for special promotions. The floor display should be well stocked, safe, and at a convenient height.

Principles of Displays - Certain principles have been proven in regard to the displaying of merchandise. The principles listed below pertain to merchandise other than plants.

1. Items should be displayed in quantity. A single item does not attract customers. A display of a large quantity attracts attention and gives the impression of demand.
2. The display should be properly arranged. The traffic pattern should be considered, and the display should be located where the largest number of people will pass it. Each table and shelf should have a relationship to the other. A theme should be established for the display. The display should be kept well-stocked, but a few items should be removed to indicate demand for the items. The display should not be so orderly that it will discourage the customer from picking the item up.

3. The display should be changed frequently. Many businesses have a specified number of days before changing a display. A display allowed to remain too long becomes ineffective.
4. The display should be kept clean and neat.

Displaying Plants - Regardless of the area used to display plants, they should be arranged in beds. The proper width of the bed is 8 feet, and it should be rectangular in shape. A 3 - foot wide walkway should be provided between beds. The plants in each bed should be of the same kind, or if a long bed is used, the plants should be grouped.

3. Advertising

Advertising is a must for a successful business and is a very important sales stimulant. The following statements will illustrate its importance. If a business is making money, it can afford to advertise. If a business is losing money, it cannot afford to under-advertise. Advertising is said to be the key to sales. If customers are not motivated to buy, sales will drop, as well as profits.

Point-of-Purchase Advertising - This type consists of a display within the business. It has been said that items properly displayed by this type are half sold. Seasonal items should be displayed several weeks in advance of the season in which they are used.

Outside Advertising - A major part of the advertising budget for most businesses is spent on this type. It includes newspapers, radio, television, handbills, direct mail, and road signs. Regardless of the advertising media selected, results must be noticeable in sales. If one media does not motivate customers to buy, another kind should be used.

Special Promotions - A special promotion is usually preceded by announcing the sale of an item at a reduced price. The purpose is to get the customer to purchase immediately. This method of merchandising is unlimited, and a good imagination is useful with this type. A handbill is often used to publicize a special promotion. Also, the wearing of unusual or attractive attire by salesmen is used sometimes with a promotion of this type.

Laboratory Exercise

Activity:
    Display and advertising

Materials:
    Coleus of varied colors
    Table - 3' x 8'
    Cardboard to make signs
    Plant labels

Procedure:

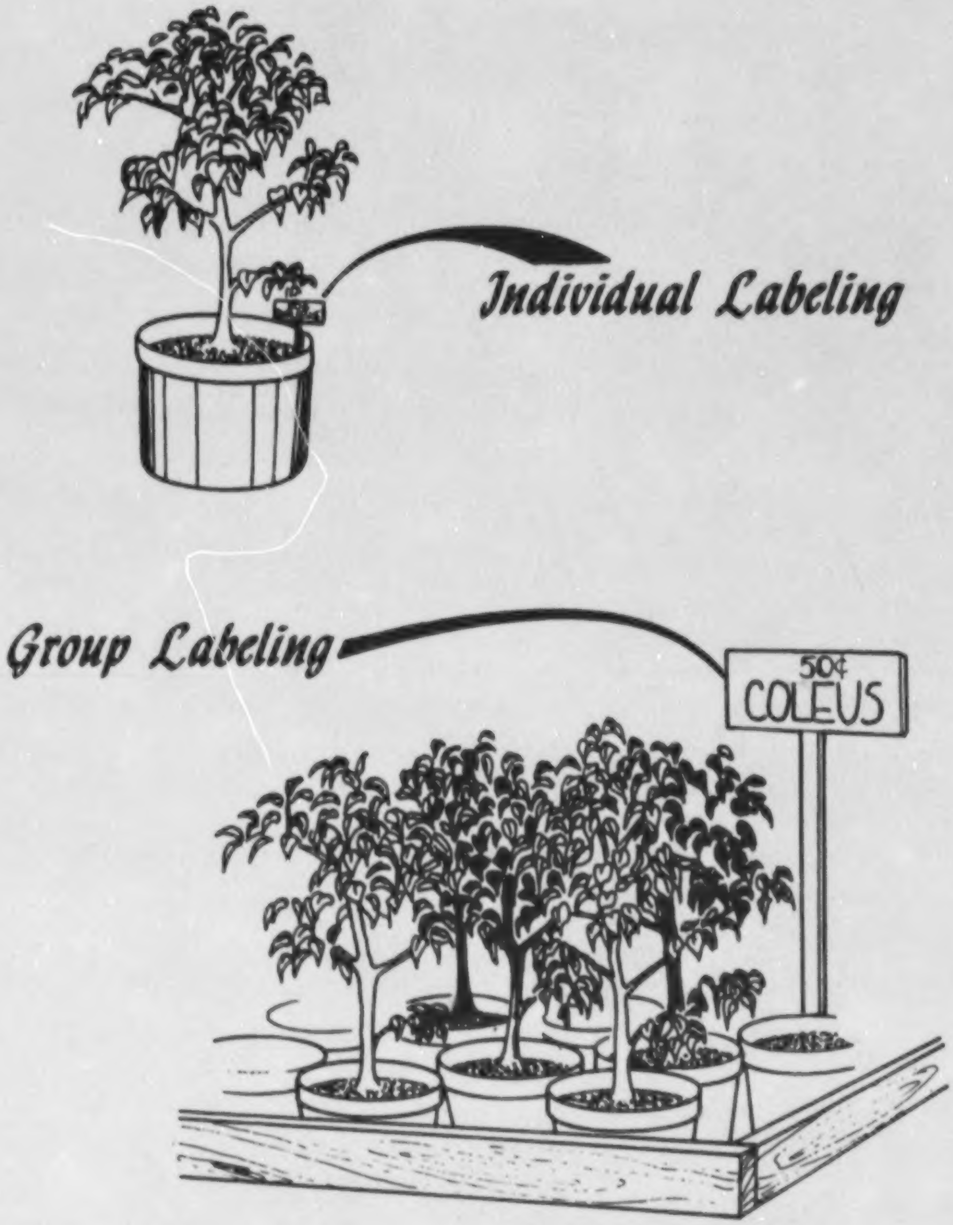
1. Set table up in a strategic location.
2. Arrange plants according to size.
3. Place one general sign on table.
4. Label end pot according to name.

References:

1. Pfahl, Peter B., The Retail Florist Business, The Interstate Printers and Publishers, Inc., Danville, Illinois, 1968.

2. "Nursery Production", Vol. 12, No. 4t, Pennsylvania State University, University Park, Pennsylvania, 1971.

LABELING PLANTS


Individual Labeling
Group Labeling
50¢
COLEUS

MARK UP AND GROSS MARGIN

MARK UP- THE AMOUNT ADDED TO THE COST TO MAKE THE SELLING PRICE

COST+MARK UP=SELLING PRICE

75¢+75¢=$1.50

$$\frac{\text{MARK UP}}{\text{COST}} = \frac{.75}{.75} = 100\%$$

GROSS MARGIN- DIFFERENCE, EXPRESSED IN PERCENT, BETWEEN MARK UP AND SELLING PRICE

VEGETABLE DUST, COST-$1.50
SELLING PRICE-$2.50
MARGIN 60%

$$\frac{\text{CASH MARK UP}}{\text{SELLING PRICE}} - \frac{\$1.50}{\$2.50} = 60\%$$

CVAE AND VEH HORTICULTURE

Unit M: Greenhouse and Nursery Business Management

Topic 3: Financial Control, Credit, Records, and Accounts

Note: All terms underlined are included in the "Glossary of Terms".

1. Securing Credit

In order for most businesses to operate today, they must borrow money. Greenhouse and nursery businesses are not an exception. The principal objective of most businesses is to increase their incomes. Business income can be increased in two ways: (1) by improving production efficiency, and (2) by increasing volume of business. Either method normally includes an increase of resources such as capital, land, labor, and equipment. Credit is usually required to increase a resource. The importance of credit cannot be overemphasized. If all sources of credit would suddenly become nonexistent, all business would eventually cease.

2. Kinds of Credit

The two kinds of credit are productive credit and consumption credit.

Productive credit is used to increase production or income and is justifiable when the estimated increase in production will increase profits. Productive credit is used to buy greenhouses, land, equipment, labor, fertilizer, plants, etc.

Consumption credit (sometimes call consumer credit) is used to purchase consumable items used by the owner's family and does not contribute to income. It is relatively easy to abuse the use of consumption credit. It is also possible through the use of consumption credit to limit the amount of productive credit available.

3. Classification of Credit

Credit, according to the period of use, may be classified as long-term loans, intermediate loans, and short-term loans.

Long-term loans are used to purchase land and buildings and are for a period of 8 to 40 years. The interest rates of long-term loans are less than those paid on intermediate and short-term loans. A mortgage on real estate usually serves as collateral for this type of loan.

Intermediate loans extend for a period of 1 to 5 years and are made to greenhouse and nursery owners to purchase equipment and possibly greenhouses or permanent structures.

Short-term loans are used to purchase fertilizer, plants, seeds, and supplies. Items purchased with short-term loans are usually expendable and are consumed in one year. Depending on their financial status and reputation, some greenhouse and nursery owners are able to secure short-term loans without using a mortgage as security. This is often referred to as a signature loan. The borrower signs a promissory note that he will repay the loan.

4. Basis for Credit

Several factors will be considered when the lender reviews the prospective borrower's loan application.

The first factors usually considered are the three C's (character, capacity, and capital). Other factors are the operator's risk-bearing ability, size of operation, records kept by prospective borrower, living costs, and income distribution.

Transparency No. 1

Nursery and greenhouse operators applying for credit are often required to furnish a net worth statement, a list of assets and liabilities. From the net worth statement, a lender can determine the prospective borrower's solvency ratio. The solvency ratio is the ratio between assets and liabilities. For example, a ratio of 3:1 means that the borrower has \$3.00 in assets for each \$1.00 of liabilities. This is determined by dividing assets by liabilities. A solvency ratio of 3:1 is considered a desirable ratio, while a ratio of 1:1 is considered a high risk.

5. Determining the Amount of Credit

There is always a certain amount of risk when one borrows money, but the borrower, as well as the lender, should attempt to keep his risk at a minimum.

As one's debt increases, the risk also increases. There are two basic principles in borrowing money: (1) do not borrow money until one can afford the risk; and (2) borrow early in career, but only after proving that one can successfully operate the enterprise or business.

Some factors that should be considered in determining the amount of credit needed are as follows:
1. Long-term outlook of enterprise;
2. Lender's attitude to conditions over which the borrower has no control;
3. Interest rate;
4. Repayment plan;
5. Possible abnormal expenses during repayment plan;
6. Expected increase in production from additional resources; and
7. Present facilities for handling an increase in production.

The above list is not inclusive. The class can probably list others.

6. Sources of Credit

Because of the many sources of credit available, a knowledge and understanding of each source should be helpful in securing credit. Since interest rates have fluctuated widely in the last few years, a range is given for the rates for different sources of credit.

Transparency No. 2

Commercial Banks - The commercial bank is one of the best sources of credit, especially for short-term loans. Most commercial banks have agricultural representatives who understand the problems of operators. Some banks provide a "package method of financing" which provides the borrower with instant credit. The credit, however, is normally for a limited amount.

Federal Land Banks - Federal Land Banks were created to provide a long-term source of credit for agriculture. They secure funds through the sale of bonds to individuals and commercial lending institutions. Because of their favorable interest rates, they are an excellent source of credit.

Borrowers are required to purchase 5 percent of their loans in land bank stock from the local association. The local associations are a form of cooperative and as a group are called the National Farm Loan Associations.

Production Credit Associations - These were established to provide a source of short-term loans for agriculture. Their organizational structure is similar to that of the Federal Land Banks. The Production Credit Association secures its funds from the Intermediate Credit Banks, who in turn secure their money from private lenders. Borrowers also must purchase 5 percent of their loans in Production Credit Association stock. Loans are made to produce crops and livestock.

Farmers Home Administration - The FHA was created by the government during the depression of the early thirties to assist tenant farmers in becoming land owners. It provides financing to producers who are unable to secure credit from any other source.

Insurance Companies - Insurance companies offer a source of long-term financing for farm real estate loans. Loans are made through bankers, brokers, company representatives, and correspondents. Insurance companies are competitive lenders, particularly in the better producing areas of the state.

Individuals - Individuals account for about 15 percent of all real estate loans. Many individual loans are the result of individuals maintaining a mortgage on land they have sold. Their loan policies and practices are varied.

7. Extending Credit

Up to this point, the information given has dealt with the borrowing of money by the greenhouse or nursery operator. The remainder of the topic will deal with the extending of credit. The operator is now on the other side of the desk.

Regardless of the size of business, certain credit policies must be established and adhered to. If the business is an established business that has been operating for several years, usually most of the previously established policies are continued, as policies once established are difficult to change without alienating customers. The operator of a new business should make a thorough study of his situation before adopting policies.

Since businessmen have found that the advantages of extending credit outweigh the disadvantages, most businesses extend credit. Credit is the name of the business game, so to speak. Advantages of extending credit are listed below:

1. More people visit the business;
2. Increases sales;
3. Increases unit sales;
4. Increases income;
5. Increases profits; and
6. Places greenhouse and a nursery in a more competitive position.

After a business has decided to extend credit, there are several things which should be known about a customer before extending him credit. These are the moral responsibility of the customer, his history of debts, and his financial status.

Another decision the businessman must make regarding credit is whether to accept the widely used credit cards or not. Credit card sales offer both advantages and disadvantages. The advantages are listed below:

1. Makes possible the extending of credit without possibility of losses;
2. Payment is received within a short period of time. The businessman's account is credited with the amount of the credit card sales as soon as he takes it to the cooperating bank;
3. No responsibility is assumed for collecting the debt;
4. No need to check the customer's credit rating; and
5. Expense and time required for keeping books on credit sales are eliminated.

Disadvantages of credit card sales are given below:

1. The 5% service charge lessens profits. Research conducted by the Horticultural Research Institute reveals that the median profit made by garden centers is 5%.
2. Less than 1/2 of 1% is the average loss from credit customers.

With the modern mechanical aids available for bookkeeping, the cost of keeping credit sales should be a great deal less than the 5% cost of credit card sales.

8. Credit and Collection Policies

As previously stated, a businessman should establish and adhere to certain credit policies. The list below includes credit and collection considerations that should be helpful in formulating policies:

1. Select policies suitable for business and adhere to them. Generally, credit sales should be limited to 30% of total sales for new businesses and not over 75% for old, well-established businesses.
2. Name, residence, place of business, business phone, and at least two references should be secured from credit customers.
3. People making phone orders should be thoroughly checked before filling orders.
4. Become a member of local merchant's association.
5. A day of the month should be selected to close accounts, and it should be used consistently. The 25th of the month is a good date.
6. Statements should be mailed monthly.
7. Unpaid accounts should be checked at regular intervals.
8. A second statement should follow before the first of the next month if the account is still unpaid.
9. If the account is still unpaid, a follow-up statement should be sent by the 15th of the month.
10. A service charge of 1% should be added to the account if the account has not been paid by the end of 30 days after billing the first time.
11. Bills that are not eventually paid should be turned over to a collection agency. This should be used as a last resort.
12. Bad debts should be written off in the year in which they occur. Bad debts should be kept below 1/2 of 1%.
13. Records of credit sales should be kept accurately.

References:

1. Pfahl, Peter B., The Retail Florist Business, Interstate Printers and Publishers, Inc., Danville, Illinois, 1968.

2. "Southern Florist and Nurseryman", April 20, 1973, Southern Florist Publishing Company, Fort Worth, Texas.

NET WORTH STATEMENT

		BEGINNING 1/1/71	ENDING 1/1/72
	FIXED ASSETS		
	Land	25,000	25,000
	Bldgs, etc.	30,000	29,250
	WORKING ASSETS		
	Tractor	4,550	4,225
	CURRENT ASSETS		
	Plants	1,500	1,500
	Cash	1,000	1,000
	Accounts Receivable	400	400
	TOTAL ASSETS	62,450	61,375
LIABILITIES	LONG-TERM	28,000	26,500
	INTERMEDIATE	200	200
	CURRENT		
	Unpaid Bills	50	50
	TOTAL LIABILITIES	28,250	26,750
	NET WORTH (ASSETS — LIABILITIES)	34,200	34,625

SOURCES OF AGRICULTURAL CREDIT

SOURCES	LENGTH of LOAN	ANNUAL INTEREST RATE	PERCENT of APPRAISAL LOAN VALUE	PURPOSE of LOAN
COMMERCIAL BANKS & TRUST COMPANIES	6-12 MONTHS	9.5-13%	TO 100%	GREENHOUSE PRODUCTION ITEMS, GREENHOUSE EQUIPMENT, PLANTS, REAL ESTATE
	2-3 YEARS	9.5-12%	70-80%	
	10-20 YEARS	10%	50-60%	
FEDERAL LAND BANK	20-35 YEARS	8-8.5%	80%	REAL ESTATE
PRODUCTION CREDIT ASSOCIATION	1 YEAR	8-9.5%	TO 100%	PRODUCTION ITEMS, GREENHOUSE, EQUIPMENT, PLANTS
	3-7 YEARS	8-9%	VARIES	
FARMERS HOME ADMINISTRATION	40 YEARS	5-6%	TO 100%	REAL ESTATE, GREENHOUSE, EQUIPMENT, PLANTS
	7 YEARS	5-6%	TO 100%	
INSURANCE COMPANIES	20-35 YEARS	8-9.5%	TO 75%	REAL ESTATE
INDIVIDUALS	15-30 YEARS	8-10%	TO 75%	REAL ESTATE, GREENHOUSE, EQUIPMENT, PLANTS
	2-5 YEARS	8-9.5%	TO 80%	

CVAE AND VEH HORTICULTURE

Unit M:	Greenhouse and Nursery Business Management
Topic 4:	Marketing
Note:	All terms underlined are included in the "Glossary of Terms".

1. Introduction

Marketing or selling has been defined as an act of assisting and persuading individuals or groups to make a decision to buy. It is a key function in most business endeavors and should be of mutual advantage to both buyer and seller. A good salesperson realizes that a high volume of sales insures his/her position and lowers the price of the product being sold. Becoming a good salesperson does not happen by accident. It is the results of sound training, either on a formal basis or through self instruction.

Americans spend 70 percent of their annual income in the approximately 700,000 retail stores in the United States. These businesses will always need employees who can sell. A good salesperson will not have trouble finding and keeping a job.

2. Becoming a Good Salesperson

A knowledge of one's self, people, and product are the basic ingredients of salesmanship. Using each of these ingredients to their fullest potential is necessary to become a good salesperson. Before anyone can fully understand others, he/she must have a good relationship with others and understand himself/herself. Then it is necessary to have a thorough knowledge of the product to be sold.

Two ways in which one may learn to sell are (1) to learn by doing, and (2) to observe other successful salespersons. The first method is learning from experience. To learn from this method, it will be necessary to become employed in a garden center or other horticultural business. Usually, it is necessary for an inexperienced employee to take another position prior to selling. This will provide the opportunity to become knowledgeable of the products.

To learn from the second method requires close observations of the methods used by a successful saleperson while sales are in progress. Such factors as customer approach, maintaining customer interest, product knowledge, demonstration of merchandise, meeting customer's objections, and closing the sale should be observed.

The following charts may be used to evaluate a salesperson. Students might evaluate a person who has recently been observed making a sale in completing the evaluation.

Chart No. 1A, No. 1B, and No. 1C

Constant analysis of sales makes a "scientific salesperson". This includes planning and executing sales and reviewing successes and failures experienced from selling. Knowledge learned from a sale, whether it was a success or failure, is applied to the next prospect.

3. Developing the Proper Personality

In sales, as in other fields of employment, the personality of the salesperson is of utmost importance. The ability of a salesperson to sell himself/herself is directly related to the ability to sell a product. Diligence and perseverance also are necessary to become an aggressive, effective salesperson.

An effective sales personality includes several qualities which includes several qualities which are discussed below:

1. Sincerity - Sincerity creates an atmosphere of confidence on the part of the customer. Insincerity creates the opposite effect.
2. Tact - A tactful salesperson is one that brings about the proper atmosphere for making a sale and soothes conflict. Contradictions and conflicts injure pride and prevent sales.
3. Enthusiasm - This may be defined as something inspiring. It involves the entire body including facial and voice expressions and actions.
4. Courtesy - Good manners and behavior are attributes of a courteous person. They give a favorable first impression which is important in selling.
5. Cheerfulness - A cheerful salesperson meets customers with a smile whether he/she feels like smiling or not.
6. Initiative - This is defined as energy or aptitude displayed. The salesperson having initiative will make sales without prodding from employer.
7. Friendliness - A friendly personality puts the customer at ease and provides a mental state for buying.
8. Persistence - A persistent salesperson is one who continues to try to make the sale. Changing the approach to make a sale may prove successful and requires persistence. Being persistent does not suggest that the salesperson should be obnoxious.
9. Memory - Remembering name and other facts about a customer are helpful in making a sale.
10. Application - The wise salesperson attempts to improve by applying that which has been learned. An old adage is that "nothing is truly learned until it is put into practice".

4. Understanding the Customer

There are two distinct types of customers. One type is mildly interested in the product, has not made the decision to buy, and must be persuaded a definite need exists for the product. With this type of customer, the salesperson also will have to create customer interest. A better job of salesmanship will be required to make the sale.

The second type has already decided the need for the product but may be undecided as to the kind (brand) to purchase. In this case, the customer must be sold on the superior feature of a product. Such factors as performance, appearance, quality, economy (time, labor, money), length of service, and prestige may be brought out. Often the naming of a person who has purchased the product is helpful.

5. Overcoming Customer Resistance

It is natural for people to have sales resistance. Most of them had to work hard for their money, and they want to get the greatest value for dollar spent. Since a person cannot usually purchase everything desired, there are two opposing factors in most every sale made. The customer must sacrifice something in order to get something else. A choice must be made between one product or another one, or between a product and another necessity or form of pleasure. The customer must decide which of the choices will give the most satisfaction or pleasure.

A salesperson must convince the customer that his product or service will provide the need, satisfaction, or pleasure. If this cannot honestly be accomplished, perhaps the sale should not be made. Anything else must be classified as high pressure selling, which is unethical and is not salesmanship.

There are several reasons why customers are resistant to purchasing. The first objection presented is rarely the actual objection. Salespersons must identify the real reason for resistance and try to overcome the reason by an explanation. To do this, the salesperson must be well-informed on the product or service.

Types of objections and ways in which they are overcome are given below:

1. Need - Objections to need are overcome by stressing the usefulness and benefits of the product.
2. Quality - Objections to quality are overcome by showing a better quality and by pointing out special features.
3. Source - Objection to source is overcome by (a) providing names and experiences of satisfied customers, (b) providing information about the company or by references to national advertising, (c) courteously correcting misunderstandings, and (d) asking the customer to use the product for a few days.
4. Price - This objection is overcome by (a) revealing hidden values, (b) emphasizing quality or usefulness, (c) showing another product which is not as expensive, and (d) having a knowledge of competing products and explaining differences in values.
5. Time - Objections to time are overcome by (a) making a future appointment, (b) inviting the customer to look at additional merchandise, (c) continuing to show a positive interest even if very busy, and (d) not closing the sale until all bonafide objections have been satisfied.
6. Thing - Objections to thing are overcome by (a) showing more suitable goods, (b) admitting the validity of an objection but showing another feature to offset

the objection, (c) admitting that the objection is reasonable but showing that it does not really apply, (d) changing the objection into a selling point in favor of the article, and (e) avoiding generalizations which have no meaning and a discouraging attitude.

6. Meeting the Customer

The impression the customer has of a business is often the results of the first contact with a salesperson. Appearance and action of the salesperson are important in forming an impression. Other factors which impress customers are well-groomed, attentive salespersons. Customers should be treated as guests.

A number of factors are important in meeting the customer. Some are listed below in the order in which they should be considered:

1. Preapproach preparation - These are preparations that should be made before the customer appears in the store.
   a. Customer information - It is not always possible for a salesperson to have this information, but when it is available, the salesperson has an advantage.
      (1) Name - address
      (2) Personal characteristics
      (3) Mental temperament
      (4) Hobbies and interest
      (5) Buying habits
   b. Sources of information - The above information may be secured by the following methods:
      (1) Participation in community activities and events
      (2) Chamber of commerce information
      (3) Comments made by civic club members
      (4) Maintaining a file card on each customer
      (5) Past sales records, credit department records
   c. Business facilities and surroundings - These items also impress customers. The following should be maintained in the best condition as possible:
      (1) General appearance of business
      (2) Lighting
      (3) Equipment
      (4) Merchandise arrangement
      (5) Personal
   d. Salesperson preparation
      (1) Neatness of appearance
      (2) Knowledge of products
      (3) Sales objectives
      (4) Knowledge of advertisements

2. Timing the approach - This deals primarily with the salesperson.
   (1) Promptness - A customer should be approached immediately after entering the business.

(2) Alertness - The salesperson must be a close and accurate observer in order to be alert.
(3) Interest in customers' problems - All the time needed to understand the customer's problem should be taken.

3. The proper approach (greeting the customer)
   a. Type of salutations
      (1) Conventional - may I help you?
      (2) Question - may I show you ... ?
      (3) Statement of fact about the product the customer is observing.
   b. Elements of a salutation
      (1) Courteous
      (2) Short
      (3) Emphasize the desire to serve
   c. Tone of voice - pleasant, enthusiastic, distinct, articulate, and ordinary
   d. Facial expression - pleasant smile and cheerful expression

7. Closing the Sale

Selling may be divided into three steps. These are (1) meeting the customer, (2) holding the customer's attention, and (3) closing the sale. The preceding information has covered the first two steps.

Obviously, closing the sale is the most important of the three steps. Not anything has been accomplished until the customer makes the purchase. Closing starts at the beginning of the sales presentation, and trial closures are appropriate as the sale proceeds.

The salesperson must induce a favorable action on the part of the customer, but the salesperson's attitude must be one of helping the customer make a wise decision. The salesperson is performing a service when a customer is not aware of his/her needs.

Anybody can sell a customer something he wants. It takes a salesperson to sell the customer needed items of which he/she is unaware. Closing the sale will be more or less automatic if the need for a product has definitely been established. One of the salesperson's functions is to help the customer decide by making trial closures. The time to close the sale is just after the customer has decided to buy.

Indications that the customer is making up his/her mind occur when the customer asks the salesperson to repeat the advantages of each item and when a request is made to remove certain items. At this time the salesperson should repeat the advantages of the item in which the greatest interest was shown by the potential customer.

Other indications of a decision to buy are as follows:

1. The customer has exhibited attention, interest, and a desire for the product.

2. A need for the item has been established.
3. Important objections have been overcome.
4. The price is low in comparison to value.
5. The product meets the customer's approval.

The salesperson can encourage the customer to make a favorable decision by leading the customer to make a number of small favorable decisions. As the presentation proceeds, more frequent agreement should be sought, and the selection should be narrowed. The selection is narrowed by concentrating upon items in which the customer is interested and removing merchandise in which the customer is not interested. Salespersons should always ask for orders. The "choice method" might be used in beginning the closing phase. That is, "do you want two or three dozen?"

SALESPERSON EVALUATION

	Very Effective	Partially Effective	Not Effective
CUSTOMER APPROACH			
1. Approached Customer Promptly			
a. Was on the lookout for customers			
b. Stopped what he was doing			
c. Approached the customer mentally and physically			
2. Welcomed The Customer			
a. Smiled			
b. Used appropriate approach			
c. Treated the customer as a guest			
3. Helped To Start Conversation			
a. Adapted himself to situation			
b. Made comment about the merchandise			
c. Anticipated customer's interest			
MAINTAINING CUSTOMER INTEREST			
1. Studied The Customer			
a. Did not jump to conclusions concerning customer's interest			
b. Sized up what would interest customer			
c. Made positive statements to reveal customer's interest			
d. Determined customer's buying motive			
e. Stimulated customer's want or desire for the merchandise			
2. Displayed Merchandise Effectively			
a. Made merchandise stand out			
b. Handled merchandise appreciatively			
c. Appealed to customer's senses			
d. Showed merchandise in good light, at eye level, on all sides			
3. Stressed Customer Benefits			
a. Showed customer how he would gain			
b. Showed customer how he would be served			
c. Showed customer benefits of owning			
d. Stressed to customer how merchandise would meet his problems			
e. Gave selling points convincingly			
4. Used Demonstration			
a. Encouraged customer to handle merchandise			
b. Interpreted value of merchandise in terms of dollars invested			
c. Dramatized features of merchandise			
d. Used showmanship advantageously			
e. Secured customer's participation			

MEETING OBJECTIONS

	Fair	Average	Good	Excellent
1. Allowed Customer To State Objections				
a. Let customer object fully				
b. Did not interrupt				
c. Understood customer				
d. Removed one objection at a time				
e. Did not argue				
2. Was Prepared To Meet Objections				
a. Did not hesitate				
b. Had right, complete answers				
c. Concentrated on what was coming next				
d. Retained control of situation				
e. Discovered real, underlying objection				
3. Anticipated Objections				
a. Welcomed customer objections				
b. Created customer confidence				
c. Convinced customer he needed merchandise				
d. Convinced customer he could afford merchandise				
e. Convinced customer his selection was wise				
4. Turned Objections Into Selling Points				
a. Used customer's own objections to heighten interest				
b. Clarified objections				
c. Translated objections into reasons				
d. Used objections to clinch a sale				
e. Used objections to establish customer confidence				

CLOSING THE SALE

	Very Effective	Partially Effective	Not Effective
1. Narrowed The Choice			
a. Listened to customer's comments			
b. Compared items			
c. Eliminated rejected items			
d. Removed unwanted items			
e. Used testimonials			
2. Established A Choice			
a. Asked for customer agreement			
b. Used power of words as which, let's, etc.			
c. Suggested or assumed a decision			
d. Presented favorable alternatives			
e. Used terms or special services as an inducement			
3. Knew When Customer Was Ready To Buy			
a. By facial expressions			
b. By positive interested actions			
c. By indirect agreement			
d. By weak objections			
e. By customer's question			
4. Asked For Action			
a. Concentrated on item being sold			
b. Restated either part or all of the selling points			
c. Stressed benefits			
d. Asked a direct statement to secure action			
e. Asked for the sale			

M-4
Chart No. 1C

Vocational Instructional Services
Agricultural Education

N-1
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit N: Horticultural Equipment

Topic 1: Lawn Mowers, Edgers, Rotary Tillers, Cement Mixers, Shredders, and Mulchers

Note: All terms underlined are included in the "Glossary of Terms".

Suggested Procedures and Activities:

Students should be allowed to perform each of the service and maintenance functions discussed in topic.

1. Power Equipment

In order to save time and labor, most horticultural operations have a large investment in power equipment. The amount, size, and kinds of equipment will depend upon the availability of labor, volume of business, crops grown, and to some extent the personal preference of the owner or operator.

The source of power for much of this equipment is provided by the small internal combustion reciprocating engine. These engines are so named because a combustible mixture of petroleum and air is burned in the piston chamber.

Small engines are used as sources of power for equipment in a number of industries. It is estimated that 6,000,000 small engines are manufactured in the United States annually. Many of this number are used on mowers, edgers, rotary tillers, cement mixers, shredders, and mulchers.

As the combustible mixture of petroleum and air burns in the piston chamber, heat is formed. This heat is the engine's source of power. The heat applies pressure to the top of the piston and a shaft is turned by a crank and connecting rod.

Five events take place in an engine where the fuel - air mixture is ignited by a spark. This series of events are called a cycle. They are as follows:

1. Atmospheric pressure pushes the fuel-air mixture into the cylinder when the pressure within the cylinder is reduced. It is reduced when the piston moves downward in the cylinder in a four - cycle engine. Pressure is applied to the fuel - air mixture by crankcase pressure or compression in the crankcase of a two - cycle engine;
2. The upward movement of the cylinder compresses the mixture of fuel - air;
3. A timed electric spark ignites the compressed fuel - air mixture;
4. Burning of the fuel - air mixture causes the mixture to expand. This expansion forces the piston downward in the cylinder and provides power; and
5. Gas products formed from step 4 are exhausted from the cylinder and a new cycle begins.

2. Types of Small Engines

Transparency No. 1

There are two types of small engines: (1) four-stroke cycle, and (2) two-stroke cycle.

In a four-stroke cycle engine, there are two complete revolutions of the crankshaft for each power stroke of the piston or complete cycle of the engine. A complete cycle consists of the following four strokes: (1) intake, (2) compression stroke, (3) power stroke, and (4) exhaust stroke.

The piston makes two strokes and the crankshaft turns one complete revolution in one cycle of a two-cycle engine (power stroke to power stroke). The two strokes are (1) compression stroke, and (2) exhaust stroke.

Some differences in four-cycle and two-cycle engines are as follows:

Four-Cycle	Two-Cycle
Oil is used entirely as a lubricant	Oil is mixed with gasoline (serves as fuel and lubricant)
Four strokes of piston complete one cycle	Two strokes of piston complete one cycle
Easier to start	More difficult to start
Difficult to use on small equipment	Less difficult to use on small equipment
Less power per unit of weight	More power per unit of weight

Several means may be used to determine if an engine is four-cycle or two-cycle.

1. If crankcase is discussed in operator's manual, the engine is four-cycle;
2. If engine has an oil sump (place to add or drain oil), it is a four-cycle;
3. The exhaust muffler on a four-cycle engine is located at the end of the cylinder, while the muffler on a two-cycle is located in the center of the cylinder; and
4. Disconnect spark plug and check compression by marking the flange of the starter pulley and cranking the engine by hand. Resistance is felt on every other revolution of a four-cycle engine, while resistance is felt on every revolution of a two-cycle engine.

Small engines are manufactured to meet many different requirements. They can be purchased with the crankshaft operating in three different positions: (1) vertical, (2) horizontal, and (3) multi-position. The crankshaft of a small engine always operates at a right angle to the cylinder.

3. Fuel Systems and Engine Speed

Small engines are generally equipped with one of two kinds of fuel systems. These are (1) gravity flow, or (2) a suction system. The fuel tank in a gravity flow system is located above the carburetor, and fuel flows into the carburetor by gravity. The cap on the fuel tank has a hole which permits the entry of air. Fuel is drawn from the tank through a line attached at the bottom of the carburetor on a suction system. Suction created by the engine pulls the fuel from the fuel tank.

Operating speed of small engines is controlled by a centrifugal type governor and air vanes. A hand throttle may be used to increase or decrease the tension on the throttle spring. The spring moves a flap attached on a hinge located in an air current. The air current is created by the fins on the flywheel. An increase in speed opens the flap and allows more fuel to enter the carburetor. A decrease in speed closes the flap and limits the amount of fuel received by the carburetor.

4. Servicing Small Engines

Small engines are a reliable source of power and will give trouble-free operation for a long period of time when operated properly and given periodic maintenance and service. Small engines are designed to operate at near maximum speed. A small engine speed of 3600 rpm is comparable to operating an automobile at 80 miles per hour. Most people would not consider the continuous operation of their automobile engines at this speed. Another reason maintenance and service are so important for small engines is they are operated in areas where there are excessive amounts of dirt and dust. The mixing of dirt and dust with oil makes an abrasion which causes severe engine wear. In the automobile industry over 50 percent of early engine failures are attributed to dirt getting into the engine.

To prevent engine problems, the small engine must be serviced regularly. Most manufacturers recommend a specific time interval for servicing the engine. A discussion is given for the different kinds of service recommended.

Service Before Operating Engine
1. Oil level in crankcase should be checked in 4-cycle engines;
2. Clean, regular gasoline is used to fill fuel tank; and
3. The proper oil-fuel mixture is used to fill fuel tank of 2-cycle engine.

25-Hour Maintenance
1. Service carburetor air cleaner;
2. Change crankcase oil is 4-cycle engine; (Crankcase oil should be changed more often if engine is operated in dirty or dusty conditions).

Annual Service
1. Clean engine (outside of crankcase);
2. Clean fuel strainer;
3. Clean crankcase breather;
4. Clean cooling system; and
5. Clean muffler.

Transparency No. 2

Small engines are cooled by cooling fins. Burned gases inside the cylinder are about 3600° F. One-third of the heat is used for power, while the other two-thirds is released through exhaust and cooling fins. Equal amounts of heat are released by these two sources. The temperature of the fins near the inner cylinder wall is about 200° F, while the extreme edge of the fins is about 100° F. The temperature is given off rapidly as forced air moves over the outer wall. If the fins are not kept clean, the engine will run hot.

A clogged muffler also causes a small engine to overheat. Back pressure is caused in the cylinder, and hot gases do not escape readily.

During the annual service, oil and fuel should be removed from all rubber parts. These cause the rubber to become soft and hasten deterioration.

Defective and broken parts should be replaced, and loose parts (nuts, etc.) should be tightened.

Procedure for Cleaning Engine

Commercial solvent, called a degreaser; petroleum solvent, such as mineral spirits, kerosene, or diesel fuel; or live steam may be used to clean a small engine. Commercial solvents are usually better than other solvents because they clean in hard-to-reach places better. Some solvents are flammable and dangerous if used in areas not well-ventilated. Therefore, solvents should be used according to directions on the label.

The steps in cleaning an engine are as follows:

1. Blower shroud and cylinder baffles are removed from engine;
2. Engine is checked for oil and fuel leaks;
3. Air-cleaner is removed and air-cleaner opening is covered with a plastic sheet, held in place with a rubber band;
4. Exhaust is removed and exhaust system is cleaned;
5. Solvent is applied to engine. This may be accomplished with a paint brush or hand sprayer.
6. Solvent should be allowed to set on engine for 5 minutes. This permits penetration and loosening of grease, etc.
7. Solvent is removed from engine surface. If a degreaser was used, it is removed by applying a stream of water. The water should be applied as long as a milky substance (degreaser-water mixture) is being removed. If a petroleum solvent was used, it is removed by applying a soap-water solution with a paint brush and flushing with water;
8. Use a putty knife or steel brush to clean areas missed;
9. Air-cleaner is replaced and tightened; and
10. Engine is started and operated for about 5 minutes, or until engine heat has dried all moisture.

Transparency No. 3

Cleaning and Inspecting Cooling System

The procedure is as follows:

1. Drain fuel tank by disconnecting fuel line to carburetor, or if tank has shut-off value it may be closed and fuel left in tank;
2. Remove flywheel shroud. It may be necessary to remove fuel tank to get to the shroud. The fuel lines should be covered with a plastic sheet to prevent foreign matter from entering line;
3. Remove recoil starter;
4. Remove blower shroud. Some cylinder head bolts may be longer than others. These bolts should be marked or noted;
5. Remove baffles and deflectors that divert air from shroud and around and over cylinder;
6. Clean insides of shroud and baffles;
7. Clean intake screen;
8. Clean dirt and foreign matter from cylinder fins;
9. Clean flywheel fins;
10. Reassemble engine in reverse order; and
11. Tighten all nuts, screws, and bolts.

Transparency No. 4

Air Cleaners

Air cleaners prevent dust and dirt from entering the engine. Three types of air cleaners are used on small engines. When properly serviced and maintained, either type will perform satisfactorily. A discussion of each type is given:

Oil-bath type - This type washes the dirt and dust particles out of the air before they enter the engine by forcing the air through an oil bath. Air enters under the edges of the cleaner and is forced to the bottom of the oil cup. After reaching the bottom of the cup, the air is forced upward. Oil in the filter is carried with the air. The dust particles are covered with oil, which causes them to lodge in the mesh of the filter element, which is a metallic maze made from crimped metal or fine wire.

Oil-filter type - This type is composed of some kind of filtering material such as aluminum foil mesh or a sponge - like plastic material. Both types are coated with oil while being installed. The air is forced over an oiled surface. Oil in the filter material picks up dust and dirt and prevents them from going into the engine.

Dry-filter type- Normally this type is made from porous paper. However, sometimes they are made from moss or hair. Very small openings in the filter allow air to pass through but prevent dust and dirt from entering engine. Dry cleaners are easier to service, provide less restrictions for air passage, and are more efficient for some engines. If the filter needs replacing, the engine will not operate properly.

Servicing Air Cleaners

Oil-bath type

1. Disconnect spark plug wire;
2. Remove filter and cover air intake with plastic sheet;
3. Check sediment deposit in oil cup;
4. Dispose of dirty oil;
5. Clean filter, cup, and other parts with solvent;
6. Clean air intake pipe going to carburetor;
7. Refill oil cup to proper level with clean oil (use same weight and grade as used in crankcase or fuel-oil mixture.)
8. Remove cover from air intake;
9. Assemble air cleaner and tighten to engine; and
10. Connect spark-plug wire to spark-plug.

Oil-filter type

1. Disconnect spark-plug wire;
2. Clean area around air cleaner;
3. Remove filter cover;
4. Remove filter element;
5. Check element and other air cleaner parts;
6. Cover carburetor intake with plastic sheet;
7. Clean filter (The best means of cleaning the filter is to use a strong solution of household detergent. Gasoline should not be used, for it will hasten deterioration and is a fire hazard.);
8. Dry filter element by squeezing and using compressed air;
9. Remove plastic sheet from carburetor air intake;
10. Clean carburetor air intake;
11. Uniformly oil filter element;
12. Assemble filter and tighten to engine; and
13. Connect spark-plug wire to spark-plug.

Dry-filter type

1. Disconnect spark-plug wire from spark-plug;
2. Clean area around air cleaner;
3. Remove filter element cover;
4. Remove air filter;
5. Cover carburetor air intake with plastic sheet;
6. Check condition of filter and other parts;
7. Clean air filter element (Paper filters are cleaned by tapping them on a flat surface, or by forcing compressed air through them. Replace dirty filters with a new filter.);
8. Remove plastic sheet from carburetor air intake;

9. Clean carburetor air intake, filter cover, and other filter parts;
10. Assemble filter and tighten to engine; and
11. Connect spark-plug wire to spark-plug.

Transparency No. 5

Servicing Fuel Strainers

The types of fuel strainers used on small engines are (1) combination screen and sediment bowl, (2) fuel tank screen (attached to either the fuel pet cock or fuel-line tank fitting), and (3) strainer (screen) attached to fuel pick-up hose in fuel tank.

The combination screen and sediment bowl is the most effective. Since water and dirt are heavier than gasoline, these settle out in the sediment bowl. This type, however, cannot be used on engines used in multi-positions.

Strainers used inside of fuel tanks are usually made of fine screen wire and attached to the fuel shut-off valve.

Engines operated in multi-positions, such as chain saws, often have strainers attached to the end of a flexible hose. The end of the hose is weighted so that the end with the strainer moves to the lowest point in the fuel tank.

It is necessary to know the type of fuel strainer on the engine before attempting to service the strainer. The procedure for servicing each type is given.

Sediment-bowl type

1. Disconnect spark-plug wire from spark-plug;
2. Close fuel shut-off valve;
3. Loosen jam nut on sediment bowl and swing wire bail to one side;
4. Remove sediment bowl with a twisting motion;
5. Remove strainer (filter screen);
6. Clean screen in kerosene or diesel fuel by swishing it back and forth;
7. Clean and dry sediment bowl;
8. Open fuel shut-off valve and drain about one cup of fuel from fuel tank;
9. Replace strainer, gasket, and sediment bowl (replace parts if needed);
10. Allow sediment bowl to fill before tightening jam nut;
11. Tighten jam nut;
12. Check for fuel leaks; and
13. Connect spark-plug wire to spark-plug.

Screen-type

1. Disconnect spark-plug wire from spark-plug;
2. Close fuel shut-off valve;
3. Remove fuel line from tank;
4. Remove shut-off value and strainer from tank, if possible;

5. Clean fuel strainer;
6. Assemble in reverse order; and
7. Connect spark-plug wire to spark-plug.

5. Equipment Powered by Small Engines

Service and maintenance of the power source (small engine) is probably the most important aspect in the operation of equipment. However, each piece of equipment in the title of this topic is discussed briefly.

Transparency No. 6

Lawn Mower - Two types of lawn movers are in use: (1) reel mower and (2) rotary mower. Both types offer advantages. Reel mowers are less dangerous, are less likely to "scalp" the turf, and will cut closer and smoother. Both hand and power models are available and both may be purchased with 4 to 12 blades. The more blades the closer the grass may be cut. The 12 -blade reel mowers are often used for cutting grass on putting greens.

A rotary mower will make a smooth, even cut on a level lawn; but on an uneven surface, it is likely to "scalp" the lawn. Because the turning blade has a great amount of force, the rotary mower can throw objects a great distance. Rotary mowers can cut taller grass and weeds than the reel type. Blades of both types should be sharp for best performance.

Edgers - These are used principally for edging grass along walks, driveways, and flower beds. However, they may be used for trimming, trenching, and beveling. The blades on edgers can be set for several different positions. Hand levers are used to control blade clutch and depth of cut.

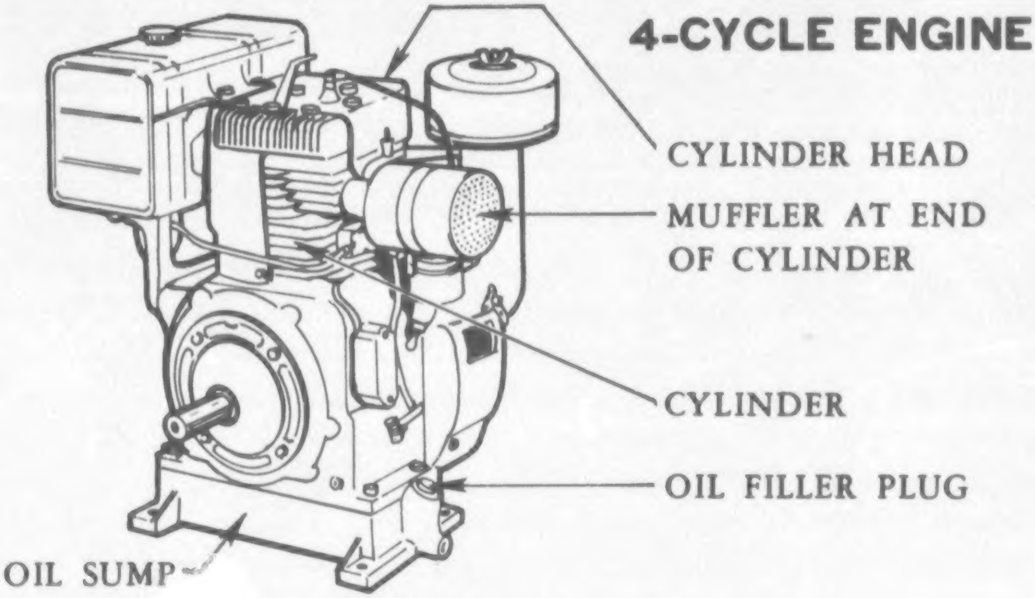
Rotary Tillers - A tiller is used to prepare seedbeds and to cultivate areas to control weeds. Several different sizes are available.

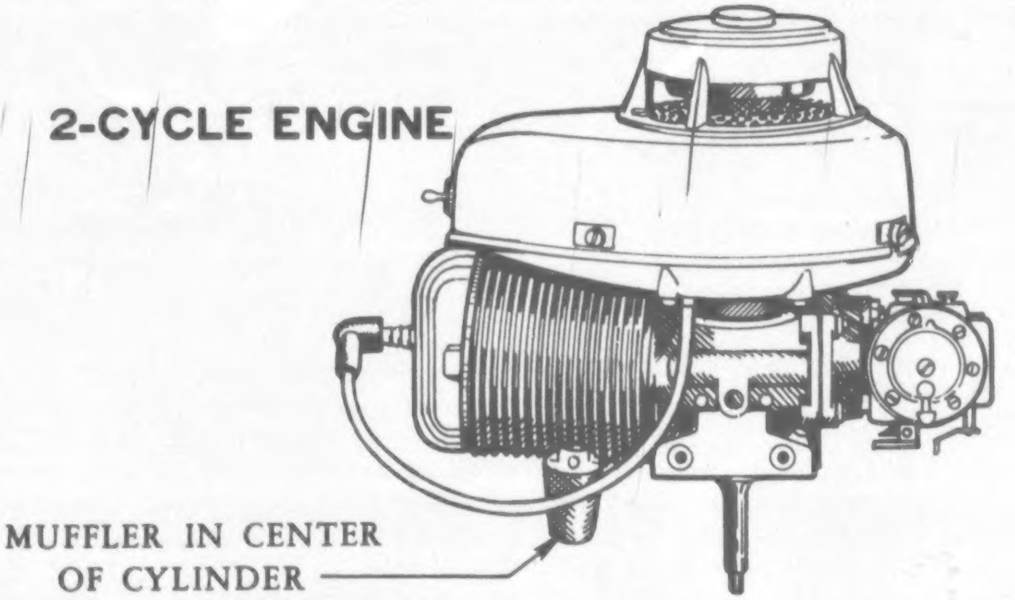
Cement Mixers - These are used to mix media. A manure spreader can also be used for the same purpose. The manure spreader may serve as a means of transporting media from one area to another.

Shredders - Several different kinds and sizes of shredders are available. Shredder capacity is usually rated by the number of bushels it will hold. Leaves and other waste materials are shredded in preparing compost and media.

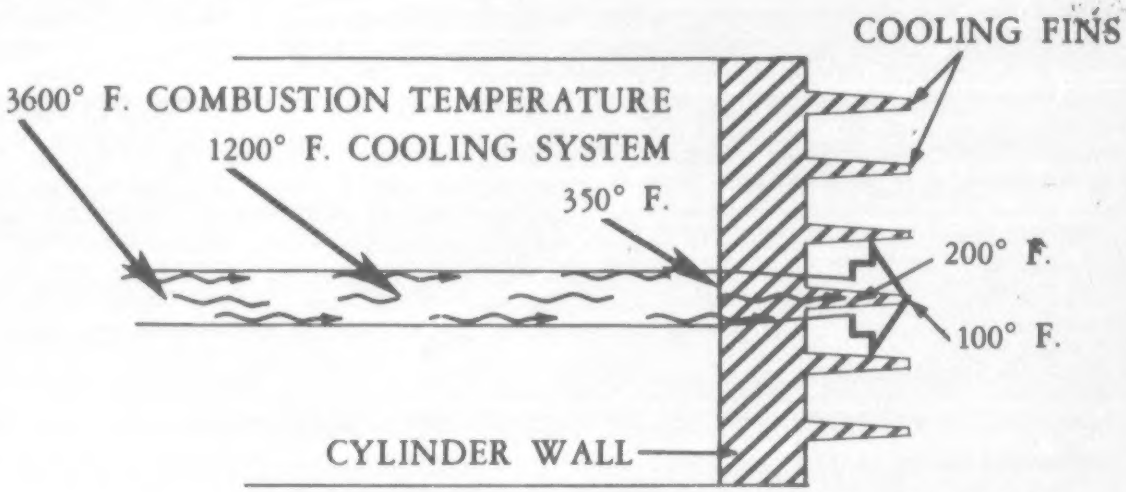
Mulchers - These are used to cut grass into fine particles or clippings. Mulching attachments are available for most mowers.

TYPES OF SMALL ENGINES

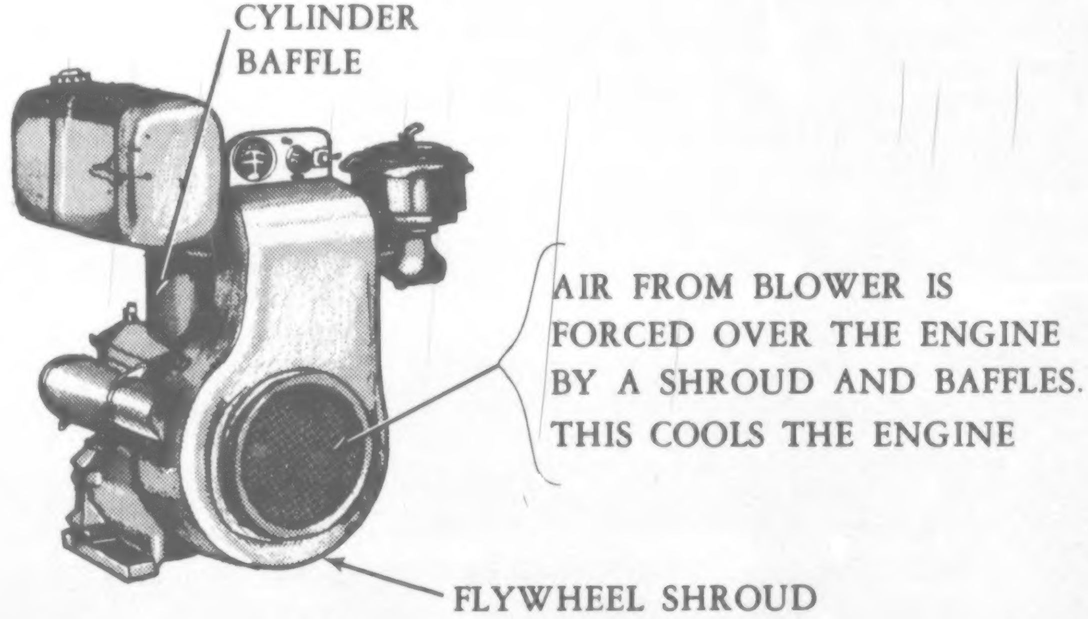

4-CYCLE ENGINE
CYLINDER HEAD
MUFFLER AT END OF CYLINDER
CYLINDER
OIL FILLER PLUG
OIL SUMP


2-CYCLE ENGINE
MUFFLER IN CENTER OF CYLINDER

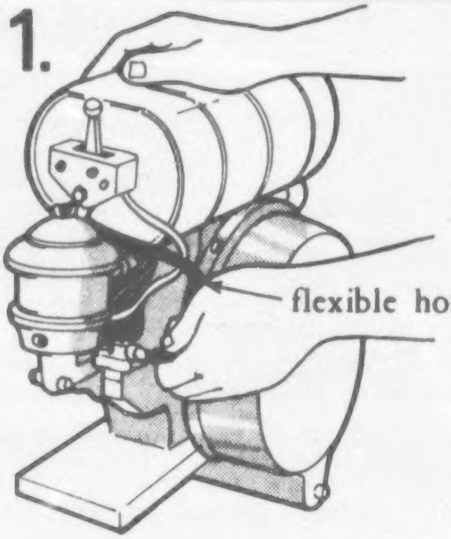
SMALL ENGINE COOLING SYSTEM

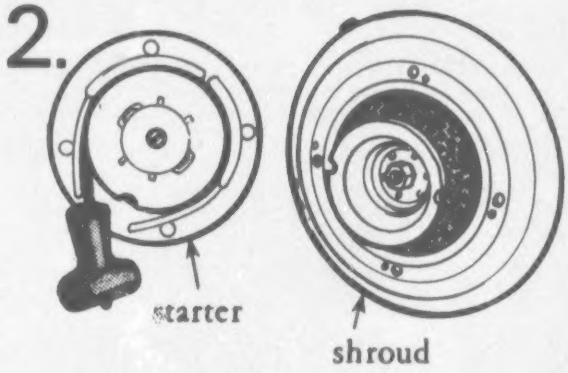

COOLING FINS
3600° F. COMBUSTION TEMPERATURE
1200° F. COOLING SYSTEM
350° F.
200° F.
100° F.
CYLINDER WALL

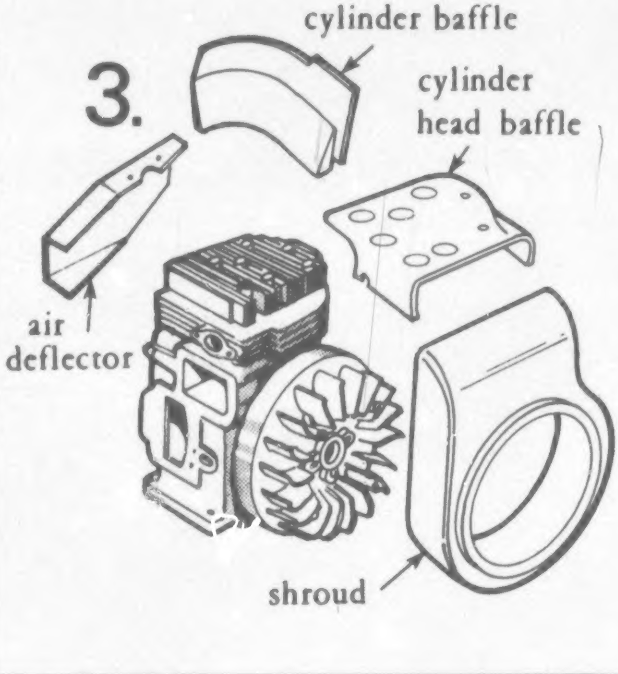
HEAT LOSSES THROUGH CYLINDER WALL

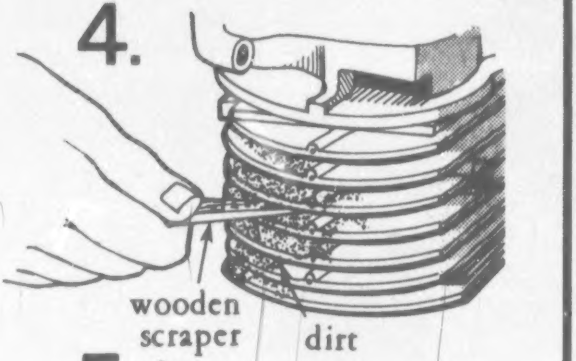

CYLINDER BAFFLE
AIR FROM BLOWER IS FORCED OVER THE ENGINE BY A SHROUD AND BAFFLES. THIS COOLS THE ENGINE
FLYWHEEL SHROUD

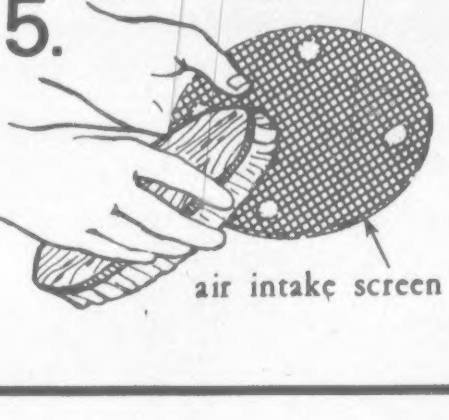
CLEANING & INSPECTING COOLING SYSTEM


1.
flexible hose


2.
starter
shroud

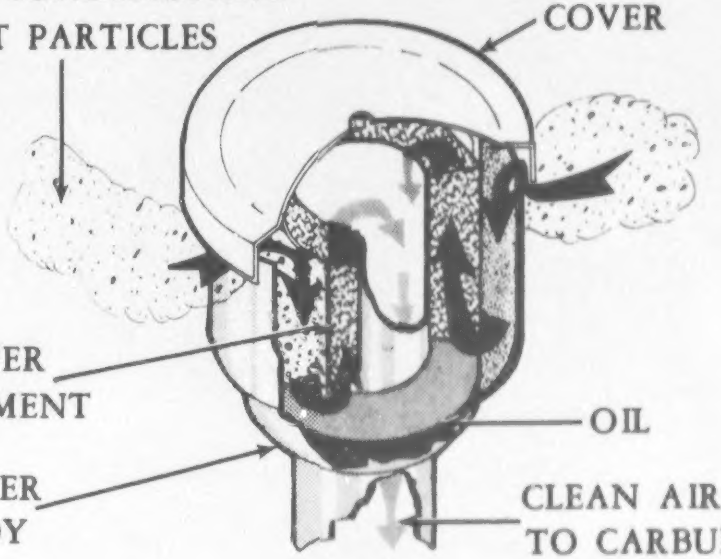

cylinder baffle
3.
cylinder head baffle
air deflector
shroud


4.
wooden scraper
dirt

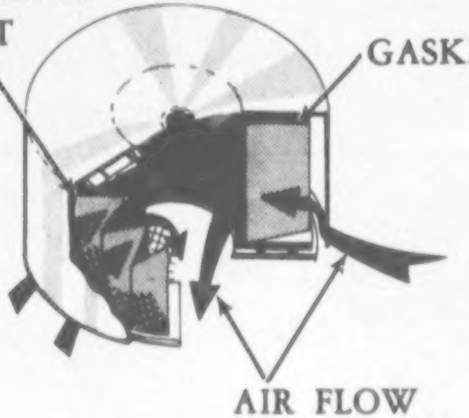

5.
air intake screen

TYPES OF AIR CLEANERS

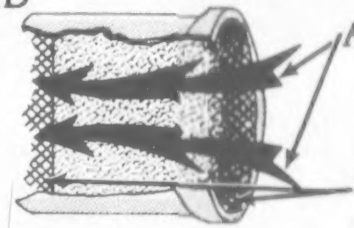
OIL-BATH TYPE

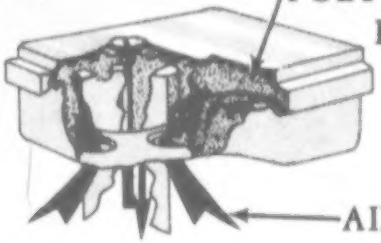

AIR CONDITIONING
DIRT PARTICLES
COVER
FILTER ELEMENT
OIL
FILTER BODY
CLEAN AIR TO CARBURETOR

DRY-FILTER TYPE

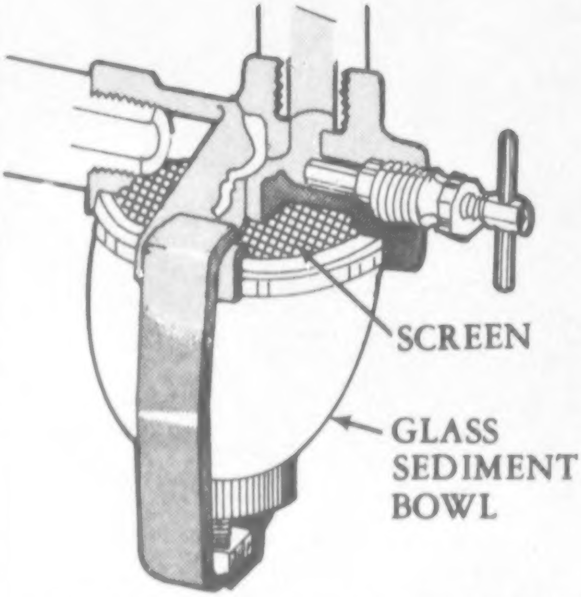

PAPER FILTER ELEMENT
GASKET
AIR FLOW

OIL-FILTER TYPES

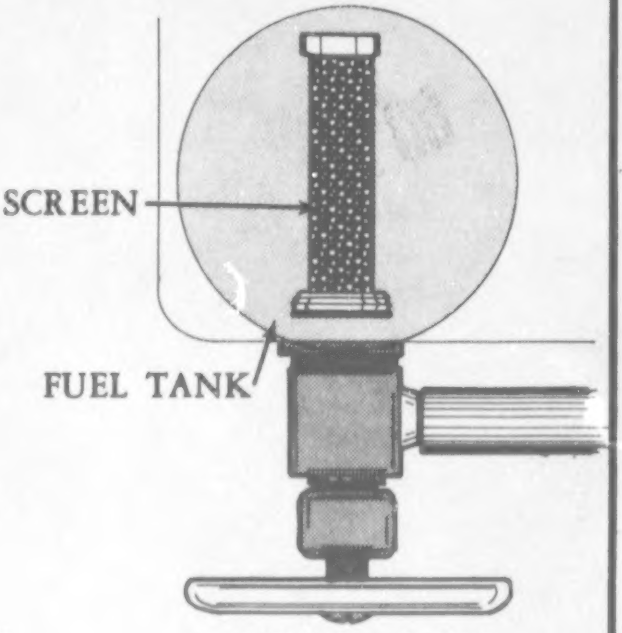

METAL MESH FILTER PAD
AIR FLOW
SCREEN


POLYURETHANE FILTER PAD
AIR FLOW

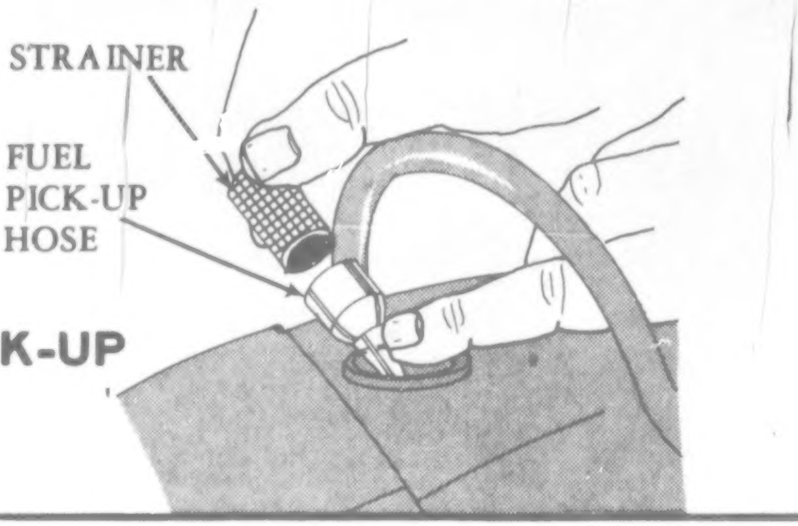
TYPES OF FUEL STRAINERS


SCREEN
GLASS
SEDIMENT
BOWL

COMBINATION SCREEN AND SEDIMENT BOWL

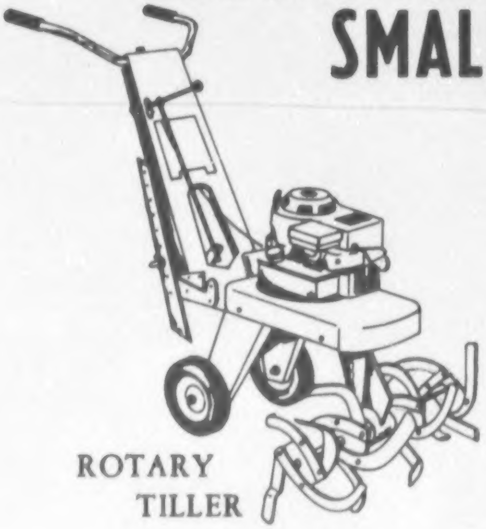

SCREEN
FUEL TANK

FUEL TANK SCREEN

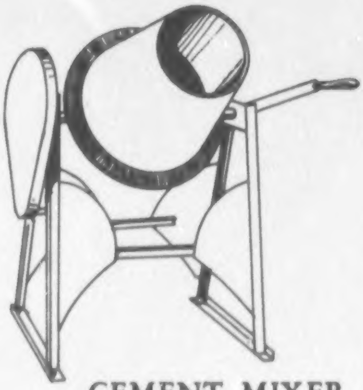

STRAINER
FUEL
PICK-UP
HOSE

FUEL PICK-UP HOSE

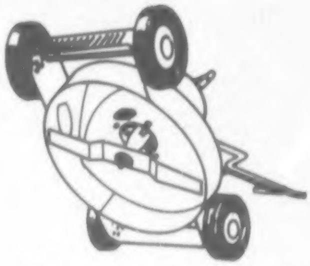
EQUIPMENT POWERED BY SMALL ENGINES



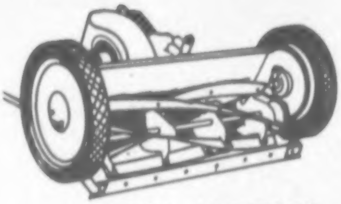
ROTARY TILLER



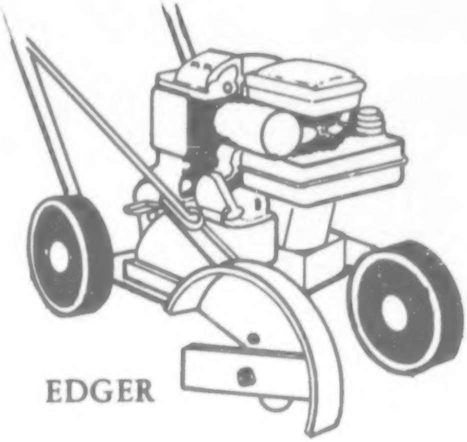
CEMENT MIXER



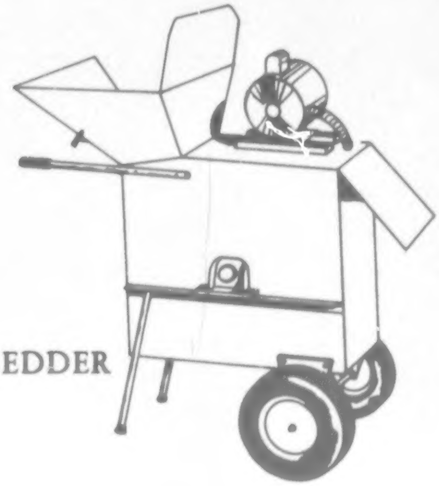
ROTARY MOWER



REEL MOWER



EDGER



SHREDDER

Vocational Instructional Services
Agricultural Education

N-2
Agdex .30/30 x 200

CVAE AND VEH HORTICULTURE

Unit N: Horticultural Equipment Operation, Maintenance, Repair and Safety

Topic 2: Sprayers and Dusters

Note: All terms underlined are included in the "Glossary of Terms."

Suggested Procedures and Activities:

It is suggested that the teacher demonstrate the operating procedures for each sprayer or duster in the department.

1. Spraying Equipment

The sprayer is being used in the production of most crops and livestock. It has become as common as the plow. The sprayer is used extensively by horticulturists to control insects, diseases, weeds, and the growth of certain horticultural crops.

Transparency No. 1

There are two kinds of sprayers, (1) low-pressure and (2) high-pressure. The low-pressure is the most common. Low-pressure sprayers are available in manual and power operated models. Manually operated models normally have a capacity of 1 to 5 gallons and operate under a compressed air pressure of 40 pounds or less. Other manually operated sprayers are the bucket pump and hose-on.

Transparency No. 2

Other low-pressure sprayers are the mobiles. There are many different designs and manufacturers of these types. These are designed for large spraying jobs and are powered with small gasoline engines.

Transparency No. 3

The sprayer shown in the above transparency is called a dismount unit because it is mounted on a tractor. The tractor PTO serves as a source of power and operates the pump.

Low-pressure, low volume sprayers are designed to spray from 3 to 50 gallons of spray mixture (pesticides, growth retardant, etc.) per acre. The operating pressure is below 150 psi.

Transparency No. 4

Depending upon the type of unit and nozzle used, the spray is controlled in three different ways. These are (1) overlapping boom spraying (spray overlaps as it hits the surface or ground), (2) band spraying (spray is placed in bands or rows), and (3) broadcast (a boomless broadcast attachment spreads the chemical evenly from one central location). The boom and other spraying attachments may be detached from most sprayers and a spray gun and hose attached. This allows the operator to move some distance away from the sprayer.

High-pressure sprayers are used mostly in orchards and vineyards. The operating pressure is 150 psi or more. It is capable of applying 300 gallons of spray per acre. High-pressure sprayers are being replaced with air-blast or mist sprayers because they require 25 percent less spray materials, 90 percent less water, and 50 percent less time than the high-pressure or hydraulic type sprayers.

Fog applicators or aerosol generators are not used in agriculture, but they are used to control flies and mosquitoes by local and state health departments.

Aircraft sprayers are another type used in agriculture. It is used for large acreages for insect and weed control and the applying of liquid fertilizers.

2. Spraying Patterns

Transparency No. 5

Spray patterns are controlled by the type of nozzle used. Many types of spray tips are available. A discussion of some types is given below.

Flat Spray Tip - It is designed for an operating pressure of 20 to 40 pounds per square inch (psi). The tip produces a fan pattern which causes the spray to overlap at surface or ground level.

Even Spray Tip - This tip also operates with a pressure of 20 to 40 psi. A uniform volume of spray is produced across the entire fan.

Hollow Cone Tips - This tip is designed to operate with a pressure of 40 to 400 psi. The spray is broken into small droplets to cover a larger area or plant.

Solid Cone Tip - This type operates under the same pressure as the hollow cone tip. It produces a circular pattern and will completely cover an area with spray.

Flooding Tip - A flooding tip is used when it is necessary to operate the sprayer near ground level and to cover a wide area. The nozzles are normally spaced 40 inches apart on a boom. The sprayer is operated with a pressure of 10 to 20 psi. This type is often used in applying post-emergence chemicals in the control of weeds.

3. Dusting Equipment

Dusters are not as popular as sprayers, but recent improvements in their design have made them more effective and increased demand. Most large dusters are built to apply chemical dusts to row crops. The dust flows by gravity to a fan. The flowing of the dust is assisted by an agitator in the hopper. After reaching the fan, the dust is forced through the hose and nozzle and onto the plant.

Several different kinds of nozzles are used. Usually the nozzles are placed as close as possible to the plant to prevent drift. A canopy or canvas may be attached to the boom to reduce drift.

Types of Dusters

There are two general types of power dusters: (1) single-outlet unit (one hose and one nozzle), and (2) multiple - outlet unit. The latter is designed for applying chemical dusts to field crops.

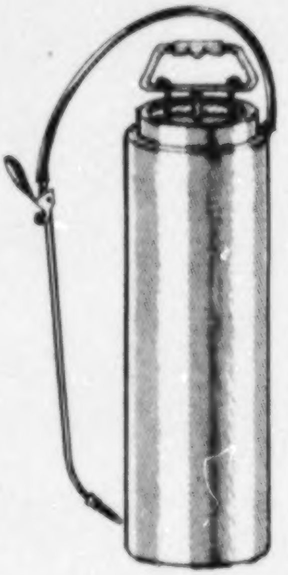
Transparency No. 6

Two principal types of manually operated dusters are the most popular. One type has a plunger which operates in the dust chamber. The plunger forces dust out of the chamber as it is pushed forward.

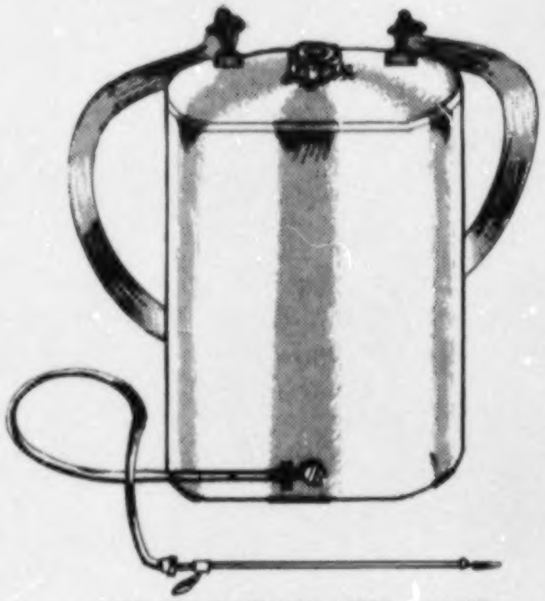
Another type is the crank and knapsack. Depending on the size, the knapsack of this type will hold from 5 to 25 pounds of chemical dust. An agitator inside the knapsack prevents the dust from becoming packed. When the crank is turned, a rotary fan or blower provides a continuous discharge of dust.

Still another type of duster is the knapsack. This type has bellows which develop an air blast. The dust is discharged intermittently; therefore, this type is best suited for spot dusting or treating crops that are planted in hills.

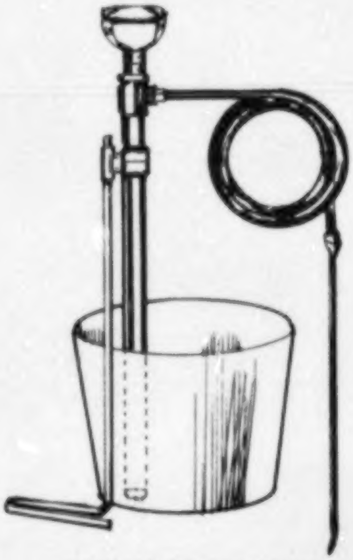
MANUALLY OPERATED SPRAYERS



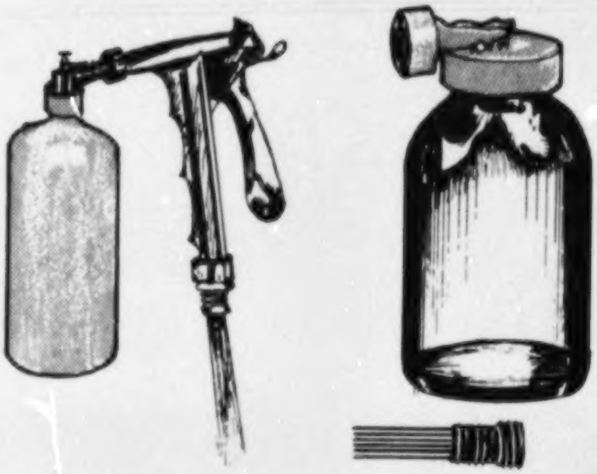
COMPRESSED AIR
SPRAYER



TROMBONE SPRAYER
WITH BACK PACK RIG

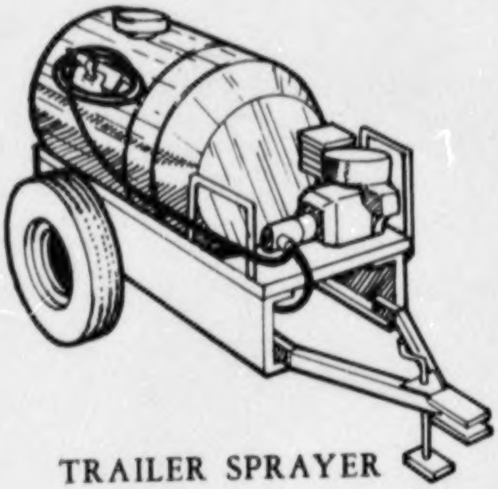


BUCKET PUMP
SPRAYER

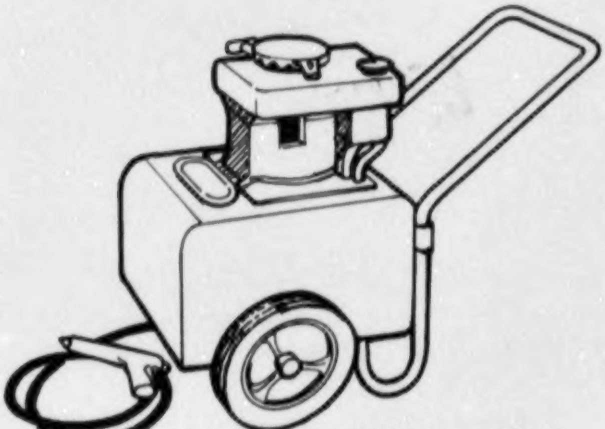


HOSE-ON SPRAYERS
TWO TYPES

MOBILE SPRAYERS

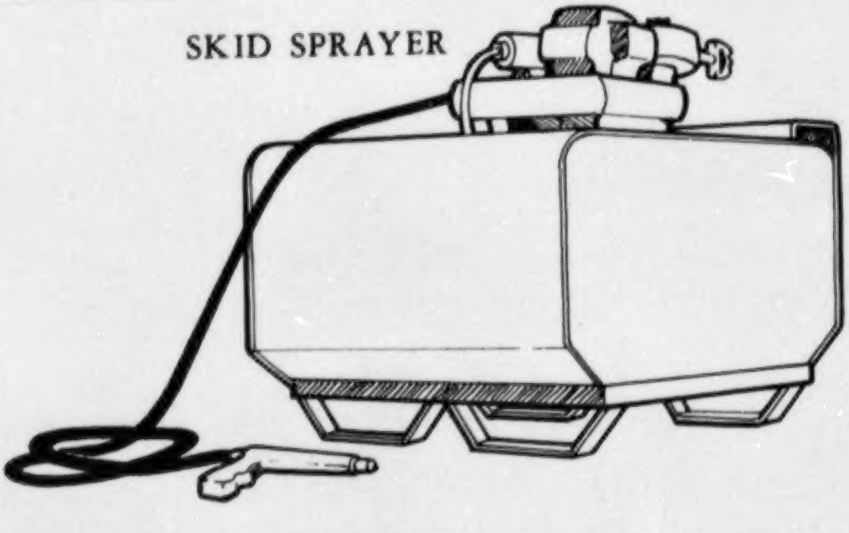


TRAILER SPRAYER

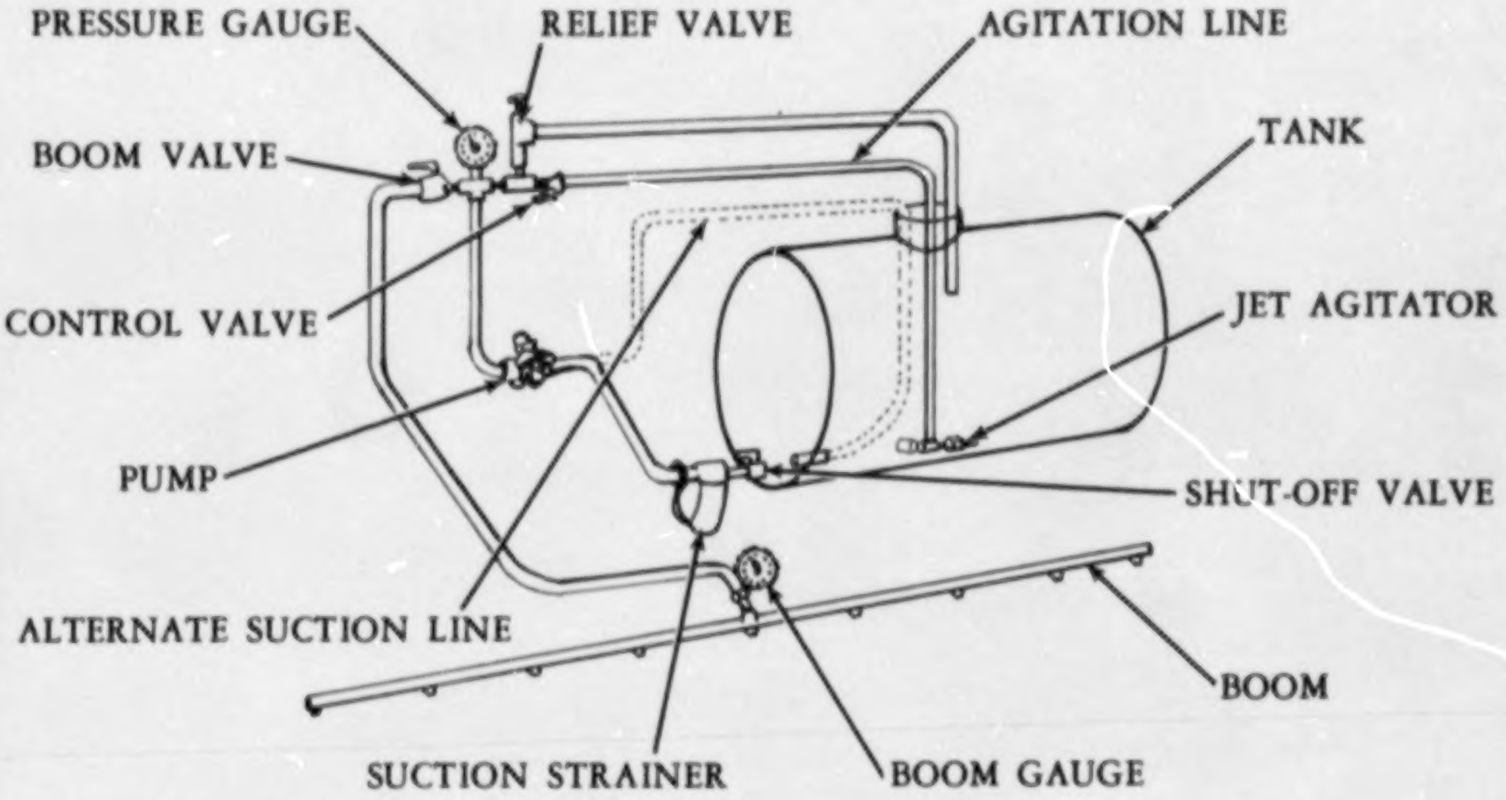


HAND MOBILE

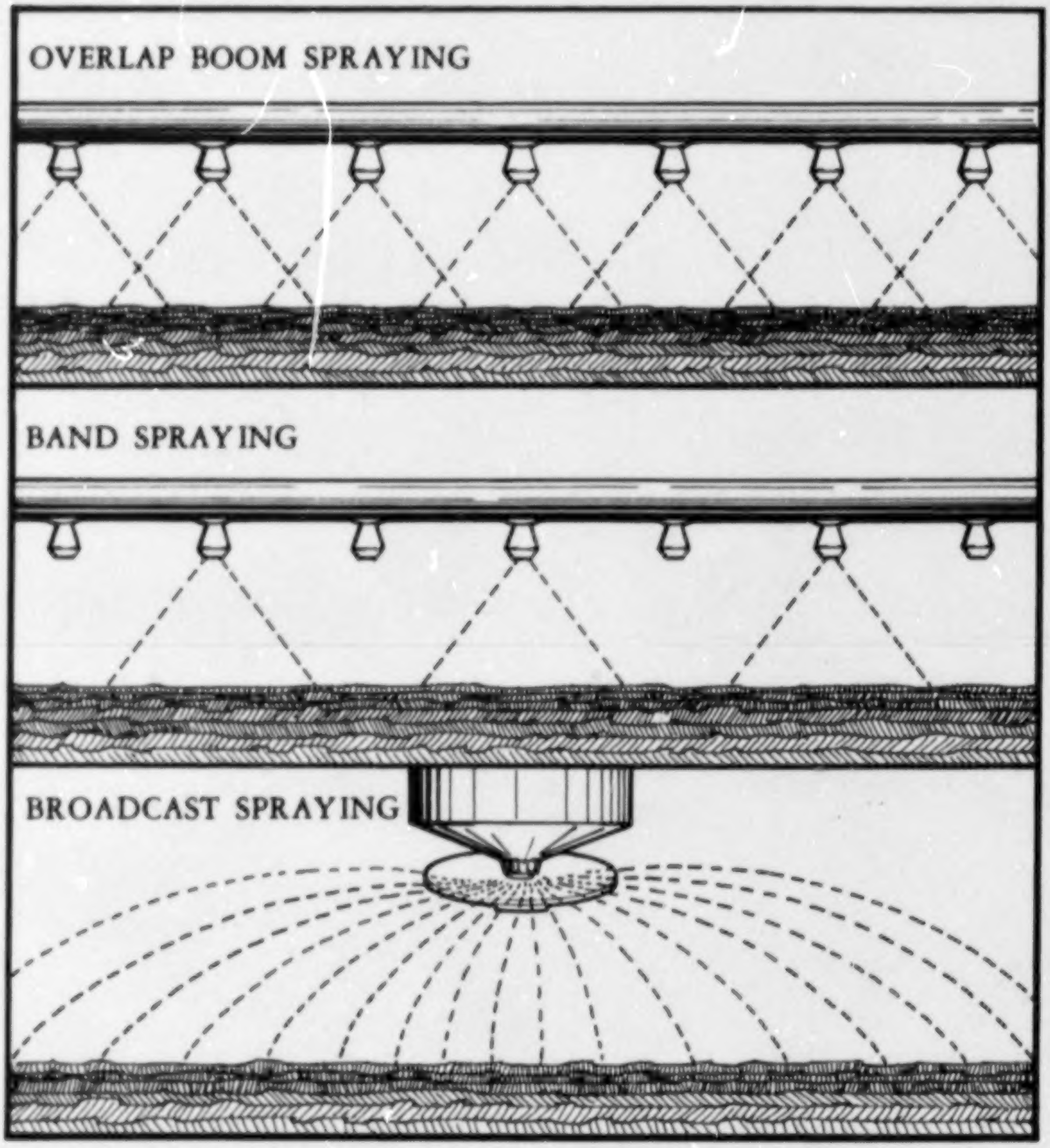
SKID SPRAYER



DISMOUNT SPRAYER UNIT

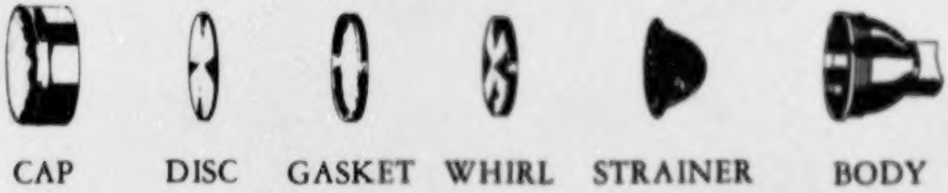

PRESSURE GAUGE
RELIEF VALVE
AGITATION LINE
BOOM VALVE
TANK
CONTROL VALVE
JET AGITATOR
PUMP
SHUT-OFF VALVE
ALTERNATE SUCTION LINE
BOOM
SUCTION STRAINER
BOOM GAUGE

METHODS OF CONTROLLING SPRAYS

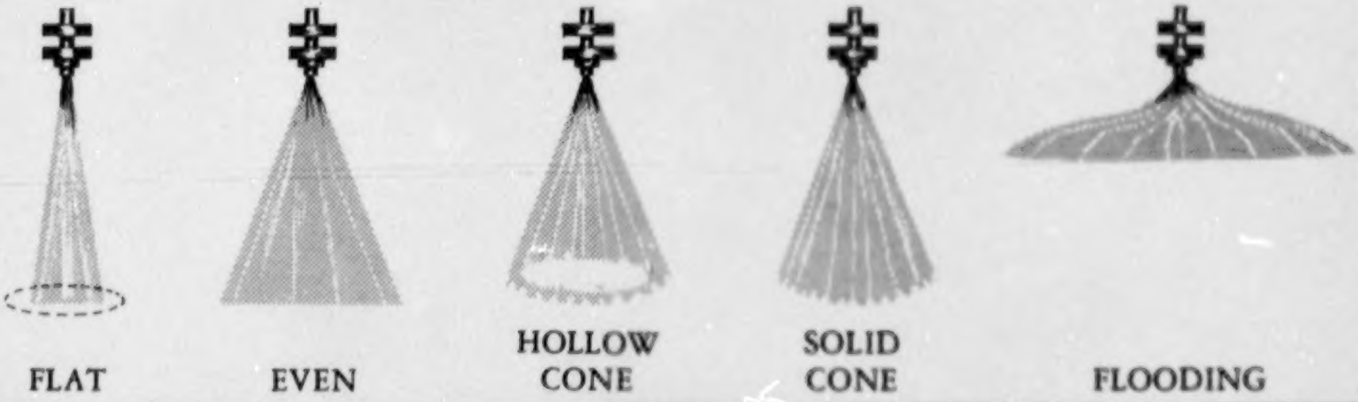

OVERLAP BOOM SPRAYING
BAND SPRAYING
BROADCAST SPRAYING

PARTS OF A SPRAY NOZZLE AND SPRAY PATTERNS

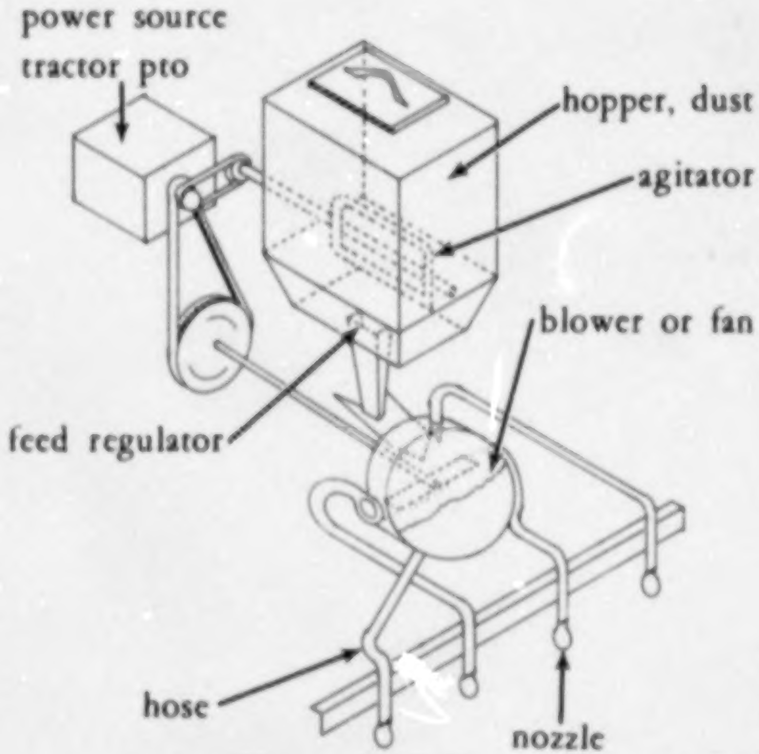
SPRAY NOZZLE


CAP
DISC
GASKET
WHIRL
STRAINER
BODY

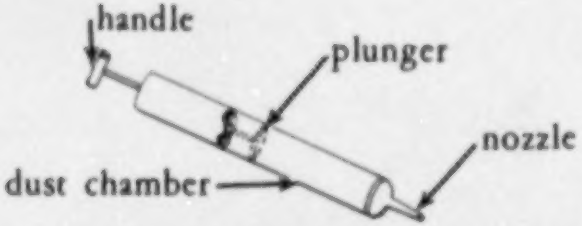
SPRAY PATTERNS


FLAT
EVEN
HOLLOW CONE
SOLID CONE
FLOODING

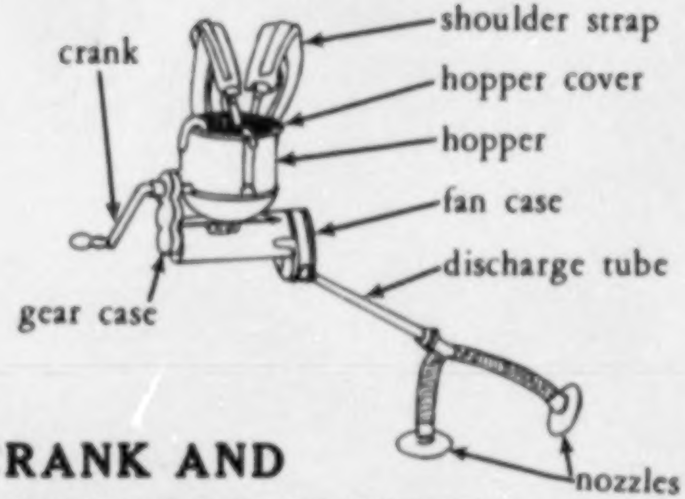
PARTS OF POWER AND MANUAL DUSTERS


power source
tractor pto
hopper, dust
agitator
blower or fan
feed regulator
hose
nozzle

POWER DUSTER


handle
plunger
nozzle
dust chamber

HAND DUSTER


crank
shoulder strap
hopper cover
hopper
fan case
discharge tube
gear case
nozzles

CRANK AND KNAPSACK DUSTER

Vocational Instructional Services
Agricultural Education

Agdex . 30/30 x 200

CVAE AND VEH HORTICULTURE

Glossary of Terms

1. Aeration - The entering of oxygen into the soil or media.
2. Soil Amendments - Materials such as lime added to the soil to change the characteristics of the soil.
3. Annual - A plant that produces blooms and seeds and completes its life cycle in one year.
4. Bacteria - Single-celled plants which increase by division.
5. Banding - Refers to the placement of fertilizer in a band along the side or below plants.
6. Biannual - A plant that completes its life cycle in two years. It goes from "seed to seed" in two years.
7. Budding - A form of grafting whereby a bud from a parent plant is placed in a normal position on the cambium of the stock.
8. Adventitious Buds - Buds that develop in an abnormal position and are usually caused by a wound to the plant.
9. Axillary Buds - Buds located in the leaf axis.
10. Bulbils - A small bulb growing on a stem.
11. Bulblets - The inner scales or growing point inside a bulb from which miniature bulbs are produced.
12. Broadcasting - Refers to the application of fertilizer to the surface of an area.
13. Cambium - The soft layer of tissue located between the bark and the wood.
14. Foot-Candles - A unit of illuminance on a surface.
15. Volatile Chemical - A chemical that readily vaporizes.
16. Collateral - Something used as security for a loan.
17. Compost - Decomposed organic matter.
18. Consumptive Credit - Credit used to purchase consumable items used by a family.
19. Productive Credit - Credit used to increase production or income.
20. Cutting - Any severed vegetative part of a plant that may be used to produce a new plant.
21. Hardwood Cuttings - Deciduous plant cuttings taken from the previous season's growth.
22. Semi-Hardwood Cuttings - Cuttings taken from evergreens.

23. Diffusion - The movement of water and nutrients from the roots to the rest of the plant.

24. Complete Fertilizer - A fertilizer containing all three of the primary elements, nitrogen, phosphorus, and potash.

25. Florets - Small flowers usually found in the heads of plants.

26. Unit of Plant Food - One percent of a ton or 20 pounds.

27. Floriculture - The production, cultivation, and management of ornamental and flowering plants.

28. Forcing - Causing plants to grow.

29. Chelated Form - Refers to a form of plant food which is bound with other materials to cause the plant food to be released slowly.

30. Fertilizer Formula - The percentage of each of the three primary elements contained in a fertilizer.

31. Genetics - A study of the laws of heredity.

32. Grafting - The uniting of a part of a plant with another plant. The graft produces wood and fruit like that of the parent plant.

33. Contact Herbicide - A herbicide that kills plants on contact.

34. Nonselective Herbicide - A herbicide that will kill any plant with which it comes in contact.

35. Postemergent Herbicide - Applying a herbicide after the weeds begin to grow.

36. Preemergent Herbicide - The application of a herbicide prior to the growth of weeds.

37. Selective Herbicide - A herbicide that will kill certain kinds of plants but will cause very little or no damage to other plants growing in the same area.

38. Humidistat - A sensing device used in a greenhouse to maintain humidity at a certain level.

39. Layering - A method of producing new plants by developing roots on a stem while it is attached to the parent plant.

40. Liners - Small plants produced by greenhouse operators and sold to other growers.

41. Media - A nutritive substance on or in which plants grow.

42. Meristem - A group of cells capable of producing permanent tissue.

43. Soil - Less Mixes - Media mixtures which do not contain soil. The ingredients usually consist of bark, vermiculite, perlite, and similar materials.

44. Mortgage - A lien on a piece of property.

45. Mulches - Materials such as leaves, straw, sawdust, pine needles, wood chips, gravel, etc. used to cover the soil around plants and to keep the soil cool or warm.

46. Botanical Names - Scientific names of plants.

47. Varietal Name - The third word in the scientific name of a plant. It is often the name of the person who first described the plant.

48. Olericulture - The production, storage, processing, and marketing of vegetables.

49. Photosynthesis - The process by which plants manufacture food. During the process plants also release oxygen.

50. Herbaceous Perennials - Soft, non-woody perennial plants.

51. Perennials - Plants that live more than two years and usually produce flowers and fruit in the second year.

52. B & B Plants - Plants that contain a ball of dirt on their roots and have been wrapped with burlap to prevent losing the dirt.

53. Bedding Plants - Flower and vegetable plants planted in beds.

54. Flowering Plants - Plants that produce a flower.

55. Foliage Plants - Plants produced for the appearance or beauty of their foliage.

56. Herbaceous Plants - Plants that have soft, non-woody stems which normally live for only one season.

57. Woody Plants - Plants with stems that live over winter and are hard or woody.

58. Ornamental Plants - Plants produced for their beauty.

59. Cross-Pollinated - The transfer of pollen from the anther of one plant to the stigma of a flower of another plant.

60. Self-Pollinated - The transfer of pollen from the anther to the stigma of a flower of the same plant.

61. Pomology - The production, processing, and distribution of fruit crops.

62. Head Pressure - Air pressure in a water pipe.

63. Asexual Propagation - Producing plants from the vegetative parts (roots, stems, leaves) of another plant.

64. Sexual Propagation - Producing plants from seeds.

65. Greenhouse Range - A number of greenhouses joined together at the eaves.

66. Growth Regulators - Chemicals applied to plants or parts of plants to encourage rooting; increase flowers, fruit, and plant size; control weeds; retard growth; and encourage setting of fruit.

67. Residue - Refers to the amount of pesticide or chemical on a product when it enters the marketing channel.

68. Rhizome - A stem growing just under the ground which may be used for vegetative propagation of plants.

69. rpm - Revolutions per minute.

70. Scion - The stem or graft wood which contains one or more buds and is inserted into the stock.

71. Residual Soils - Soils that are formed in place from rock.

72. Solum - The term used for true soil.

73. Foliage Spray - Spray applied to plant foliage.

74. Antidote Statement - A statement required on the containers of chemicals explaining methods that may be used to counteract the effects of the chemical.

75. Stock - The part of a plant that receives a graft.

76. Container Stock - Plants grown in a container until they are marketed.

77. Potted Stock - Stock grown for a period of time in a pot. They may be transplanted in a larger container or planted in a nursery row.

78. Stolons - Runners that produce plants when the node comes in contact with soil. An example is the runners produced by Bermudagrass.

79. Forcing Structure - A structure such as a greenhouse, lathhouse, hotbed, or coldframe used to grow and produce plants.

80. Callus Tissue - Tissue formed between the graft and scion.

81. Tolerance - The amount of a pesticide or chemical which scientists have determined may safely remain as a residue on a food crop without injury to the consumer.

82. Topdressing - Placing fertilizer on top of or just beneath the soil surface.

83. Translocation - The movement of soluble nutrients through plant tissues.

84. Transpiration - Evaporation of moisture through the leaves of plants.

85. Deciduous Trees - Trees that lose their leaves during the winter.

86. Tubers - Swollen underground stems or roots containing stored food. Tubers are used in vegetative propagation of plants.

87. Manual Watering - Watering plants with a hose, bucket, or some other manual means.